Hashicorp Terraform

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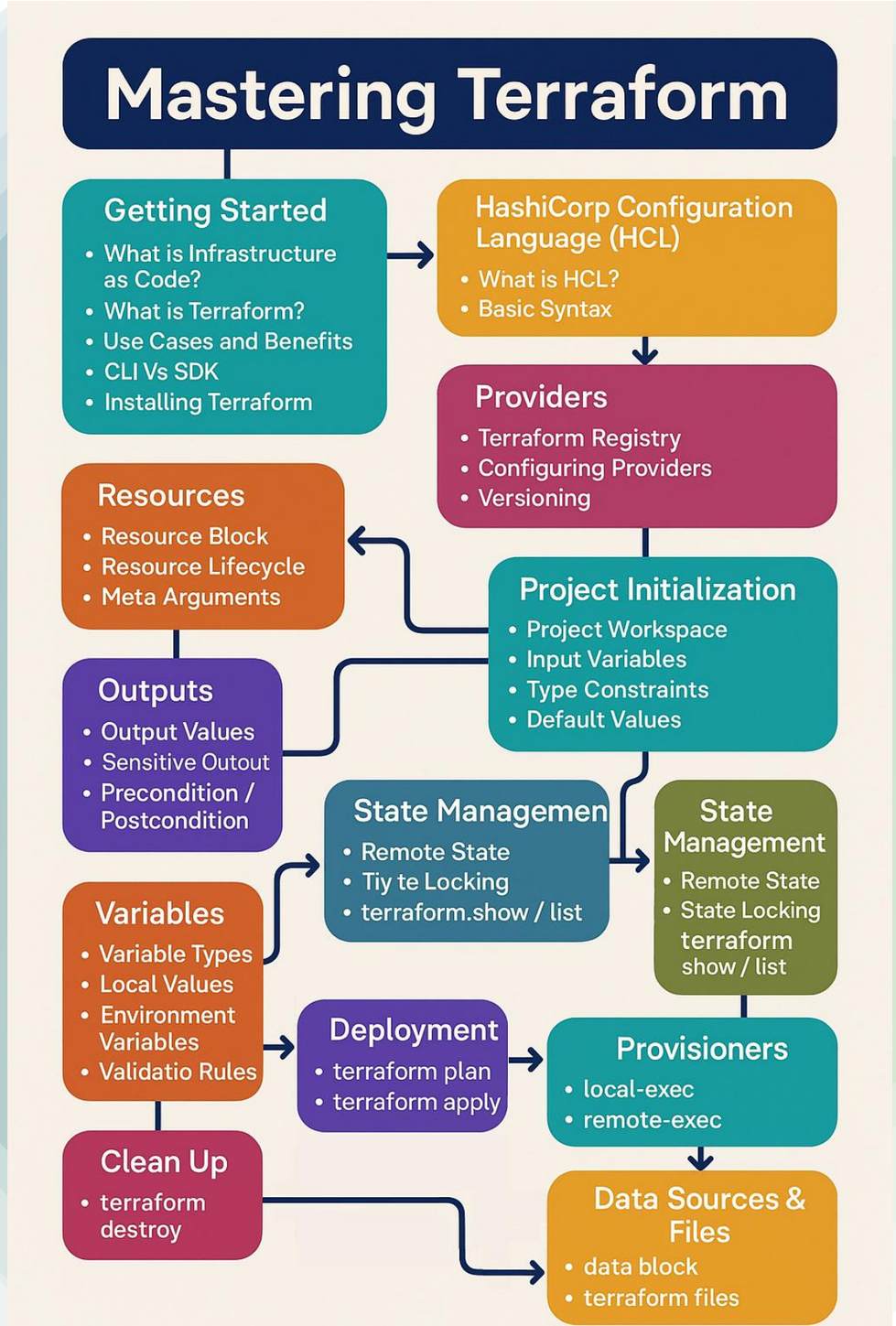

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Teaching Terraform

combination of explanation and demo

with step-by-step guide on GitHub

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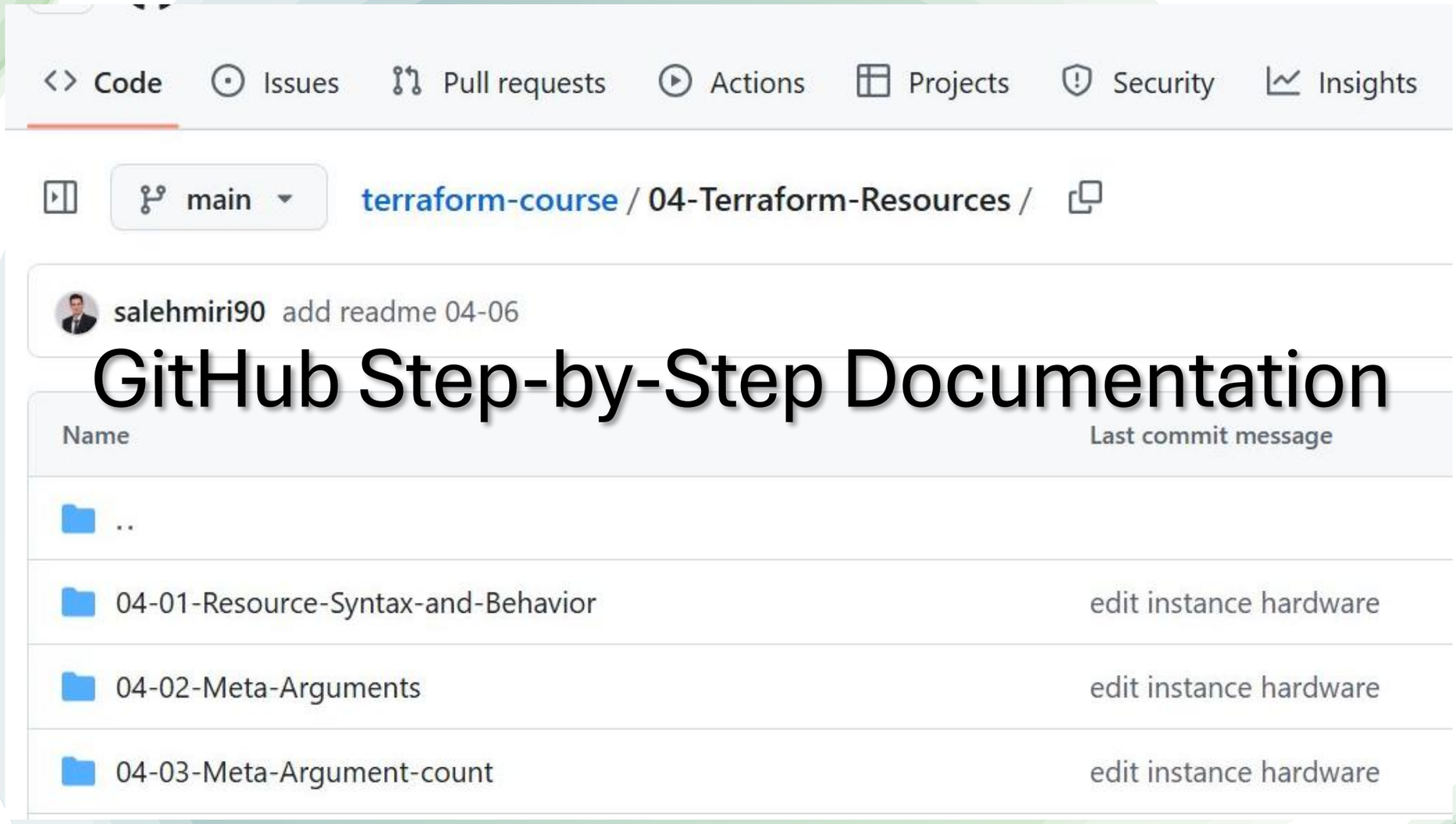

GitHub Step-by-Step Documentation

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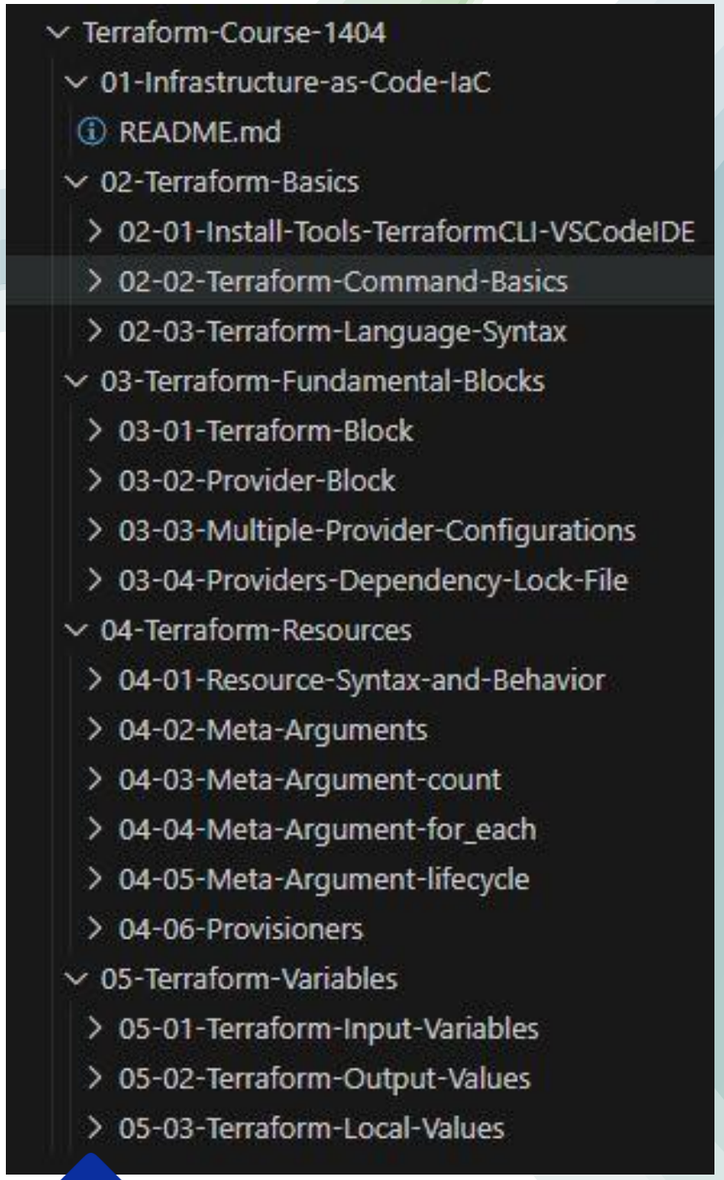
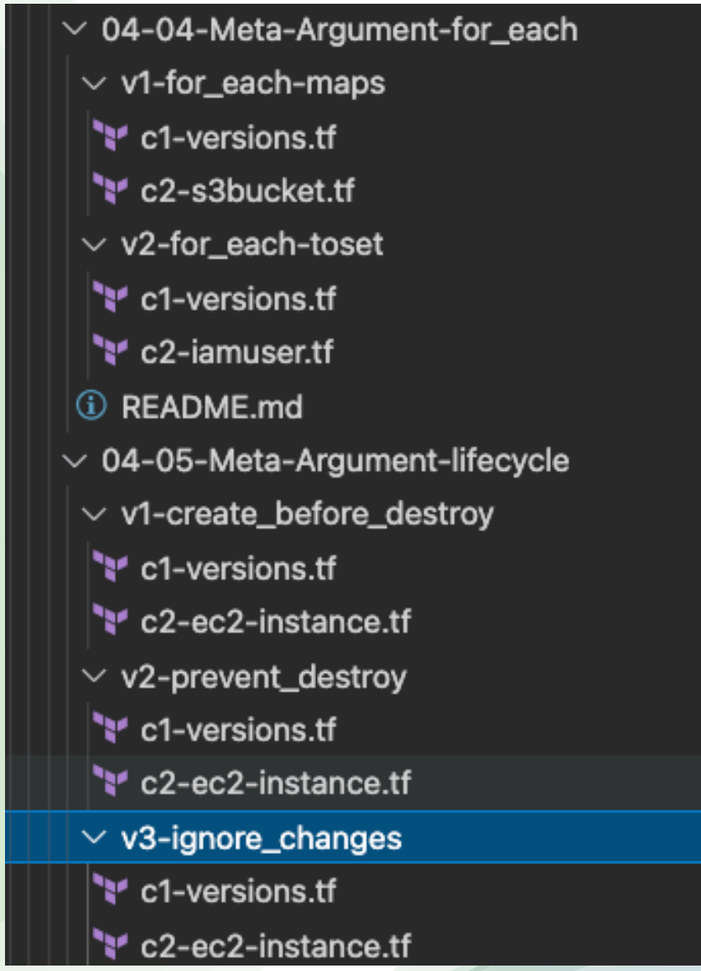


Practical Examples For Each Concept



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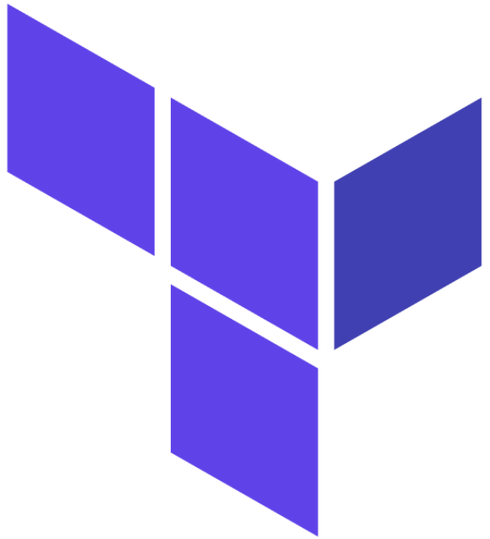
Introduction

- **HashiCorp Products?**
- **What is Terraform?**
- **Is it worth to learn Terraform in 2025?**
- **Prerequisite for course**



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HashiCorp Products

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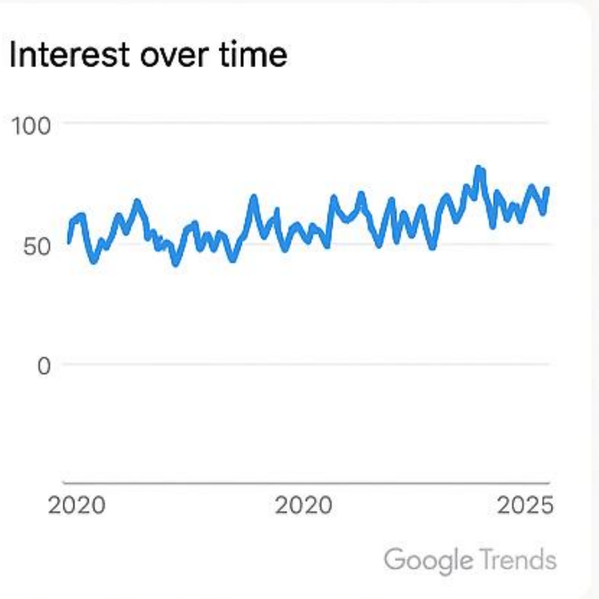
Is it worth to learn Terraform in 2025?

Yes, learning Terraform remains a key and popular skill in IT and DevOps



Current Status of Terraform In 2025:

- High popularity: Terraform is still one of the most widely used IaC tools (IaC) tools
- Broad adoption: Many companies and organizations continue to use and invest in Terraform
- Ongoing development: New features and improvements are being regularly released

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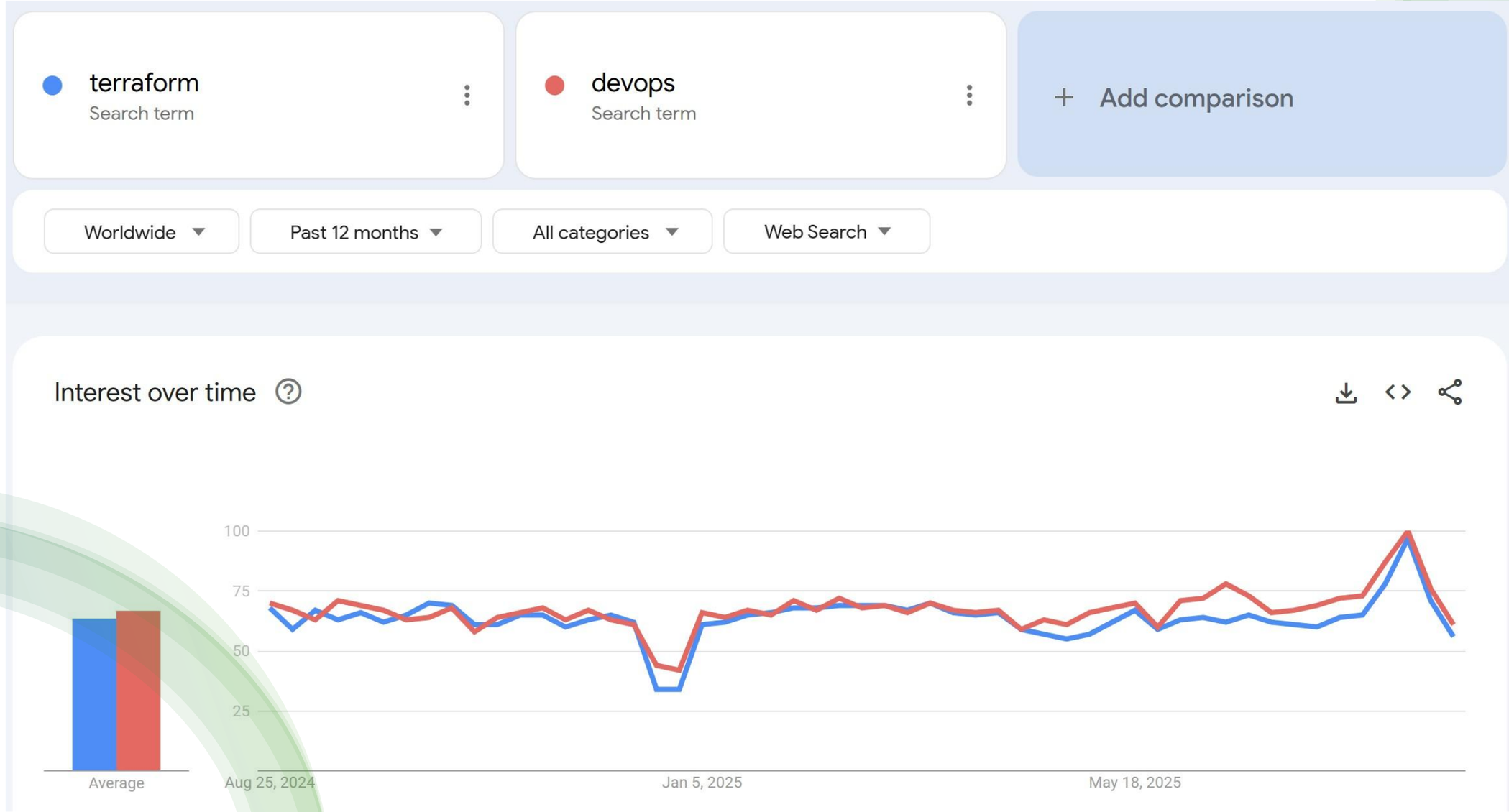
Google Trends – Past 1 Year



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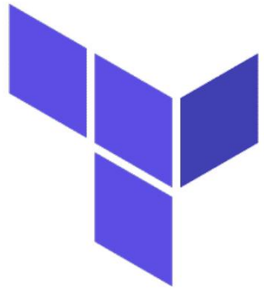
Prerequisite for this course?



HashiCorp Terraform

Google Cloud Platform

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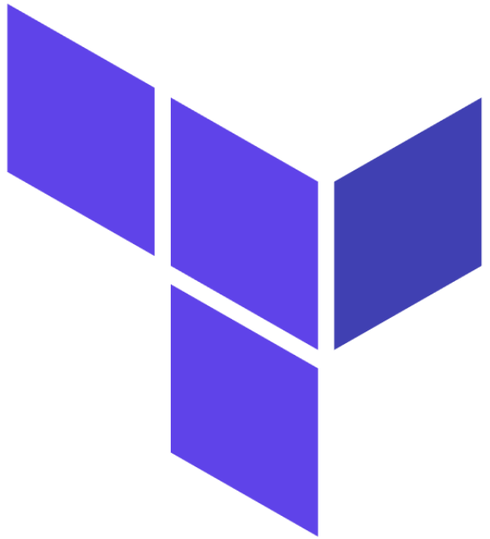
01: Infrastructure as Code (IaC)

- Infrastructure as Code?
- Traditional Way of Managing Infrastructure
- Manage using IaC with Terraform
- Terraform placement in Infrastructure
- Declarative vs Procedural approaches
- Pull vs Push execution methods
- Terraform vs Ansible
- Terraform Website and Providers



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Infrastructure as Code?

Configuration Management

ANSIBLE

puppet

SALTSTACK

Server Templating

docker

HashiCorp
Vagrant

HashiCorp
Packer

Provisioning Tools

HashiCorp
Terraform

CloudFormation

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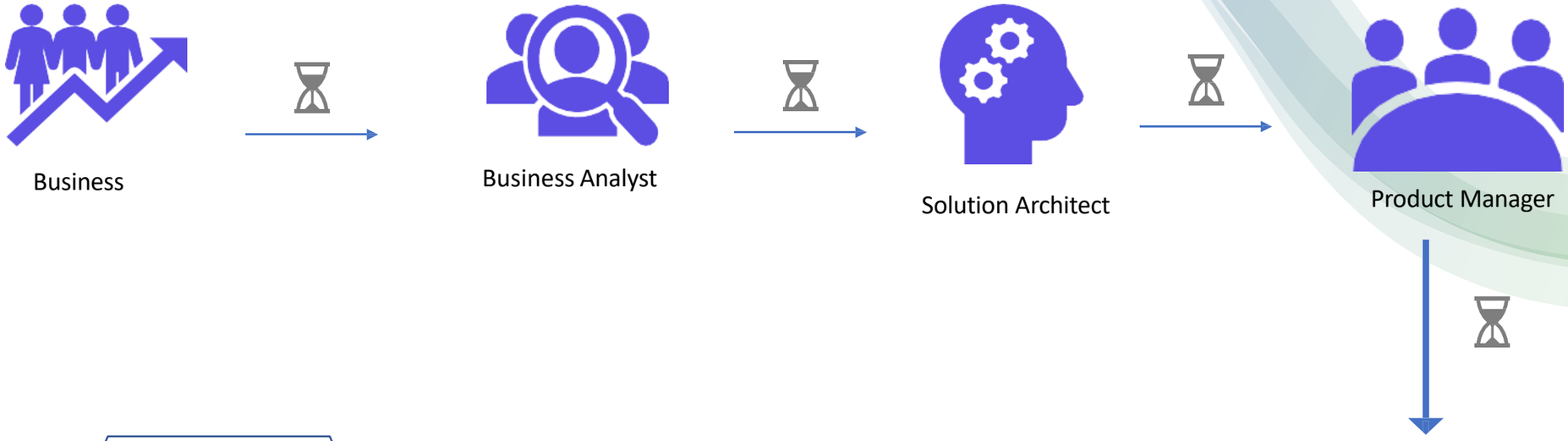
Traditional Way of Managing Infrastructure



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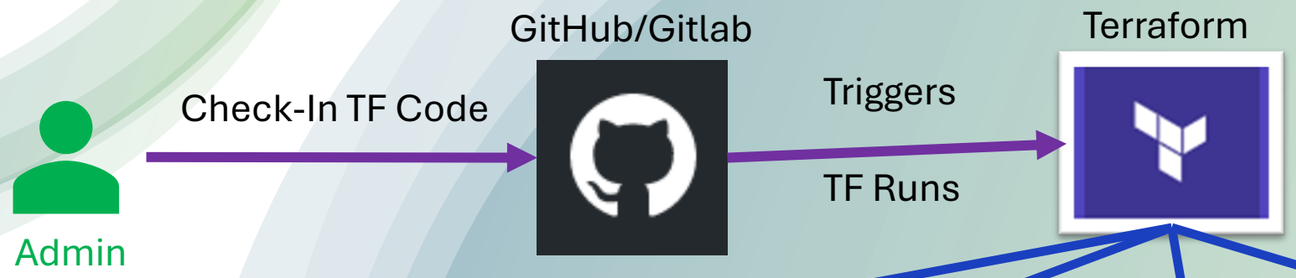
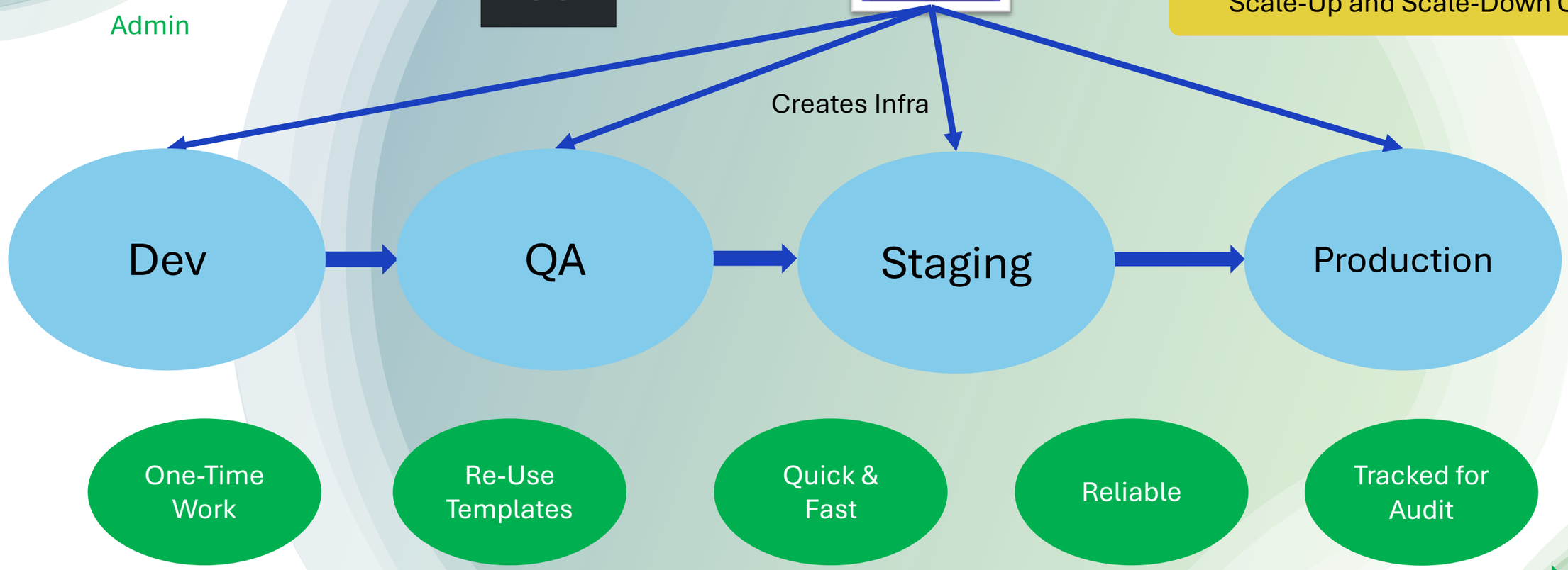
Manage using IaC with Terraform



DevOps / CI CD for IaC

Scale-Up and Scale-Down On-Demand



One-Time Work

Re-Use Templates

Quick & Fast

Reliable

Tracked for Audit

Total Time: 25 Days reduced to 5 days, Provisioning environments will be in minutes or seconds

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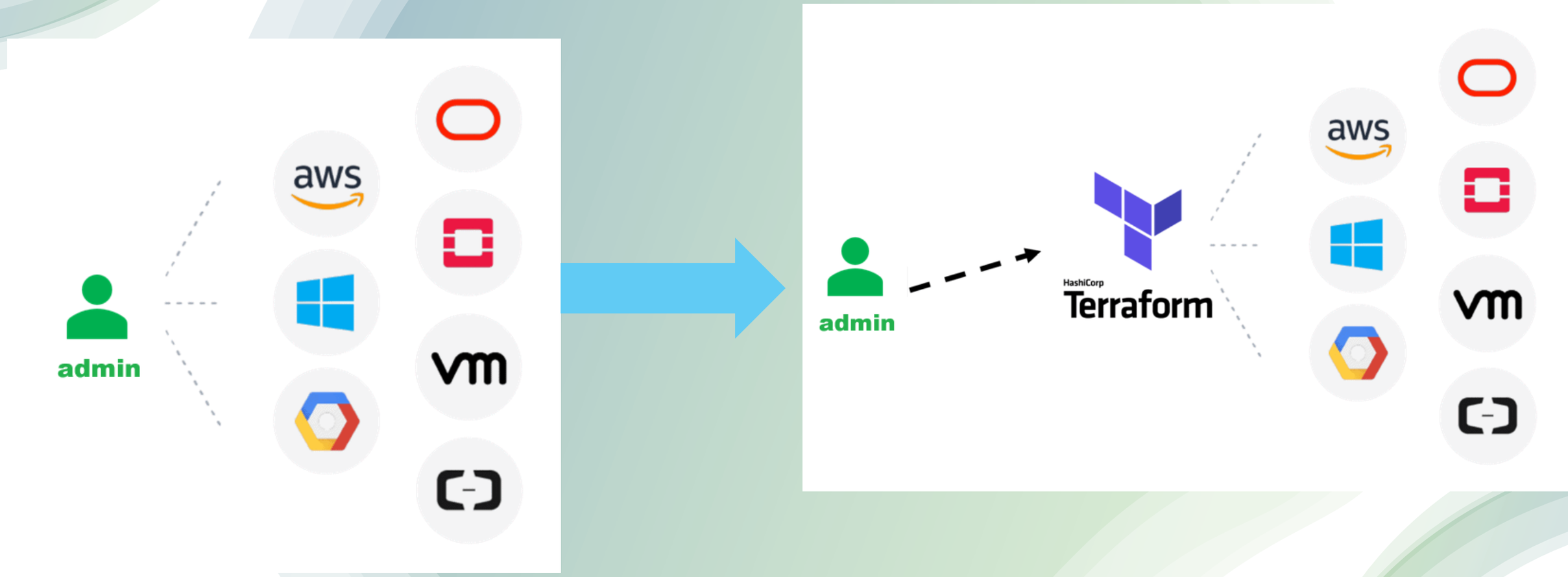
Manage using IaC with Terraform

Visibility	IaC serves as a very clear reference of what resources we created, and what their settings are. We don't have to navigate to the web console to check the parameters.
Stability	If you accidentally change the wrong setting or delete the wrong resource in the web console you can break things. IaC helps solve this, especially when it is combined with version control, such as Git.
Scalability	With IaC we can write it once and then reuse it many times. This means that one well written template can be used as the basis for multiple services, in multiple regions around the world, making it much easier to horizontally scale.
Security	Once again IaC gives you a unified template for how to deploy our architecture. If we create one well secured architecture we can reuse it multiple times, and know that each deployed version is following the same settings.
Audit	Terraform not only creates resources it also maintains the record of what is created in real world cloud environments using its State files.

Terraform Placement



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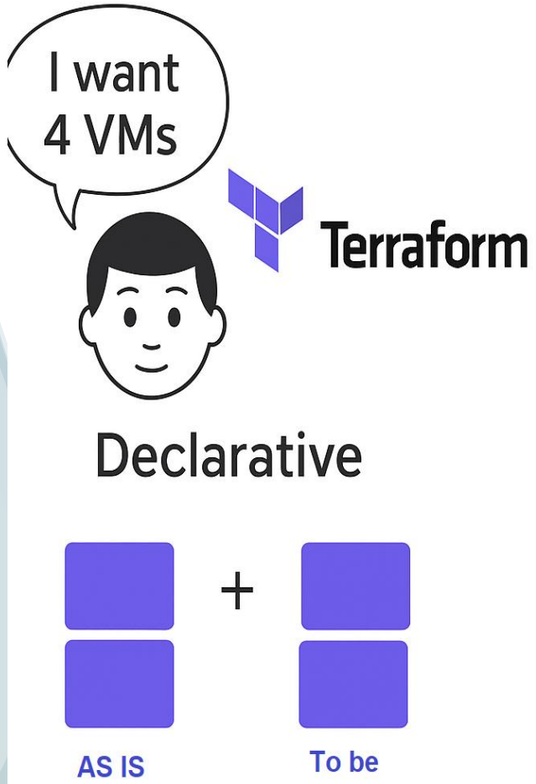
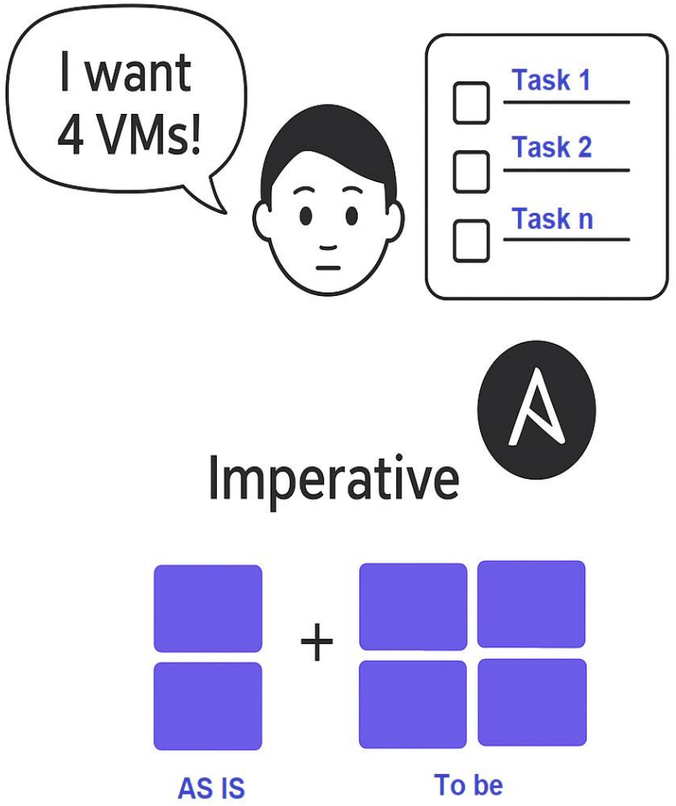
Declarative vs Imperative (Procedural)





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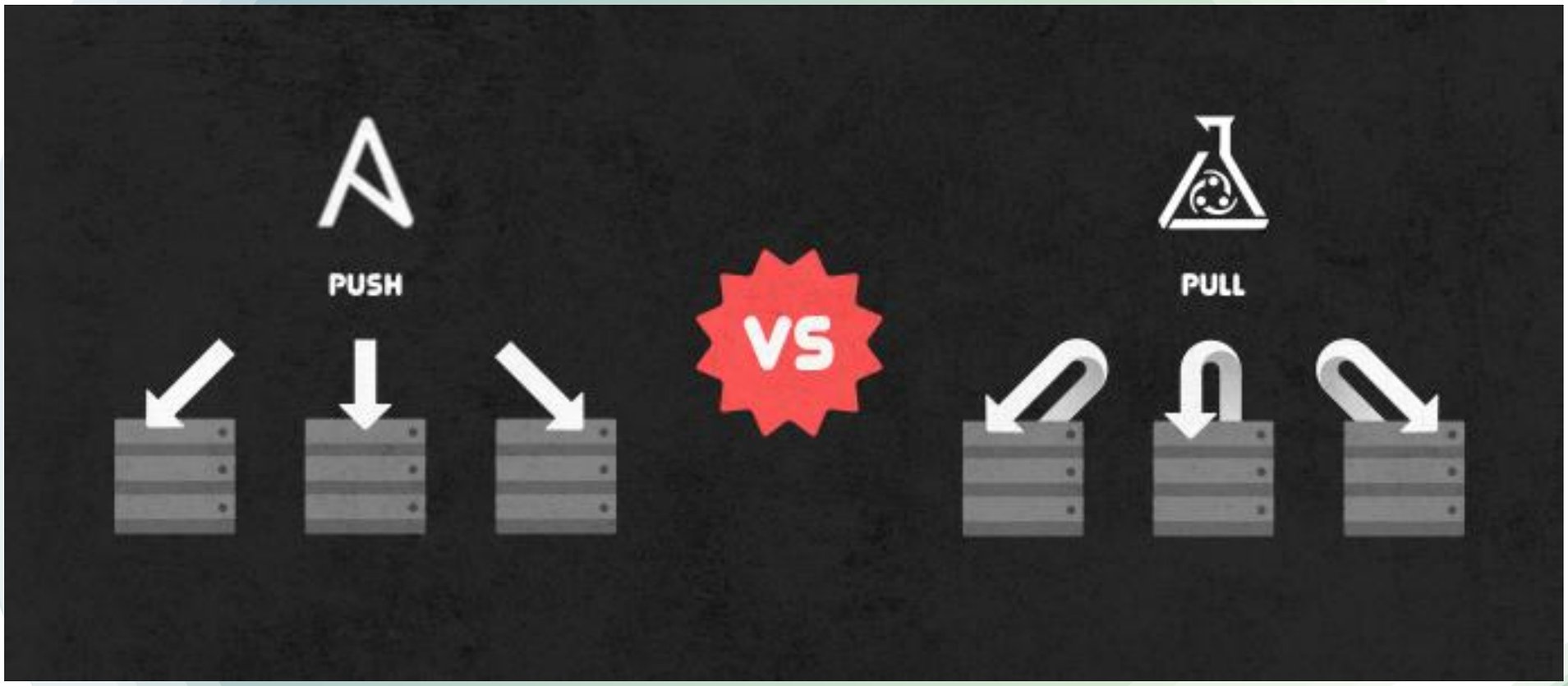
Pull vs Push Execution Methods



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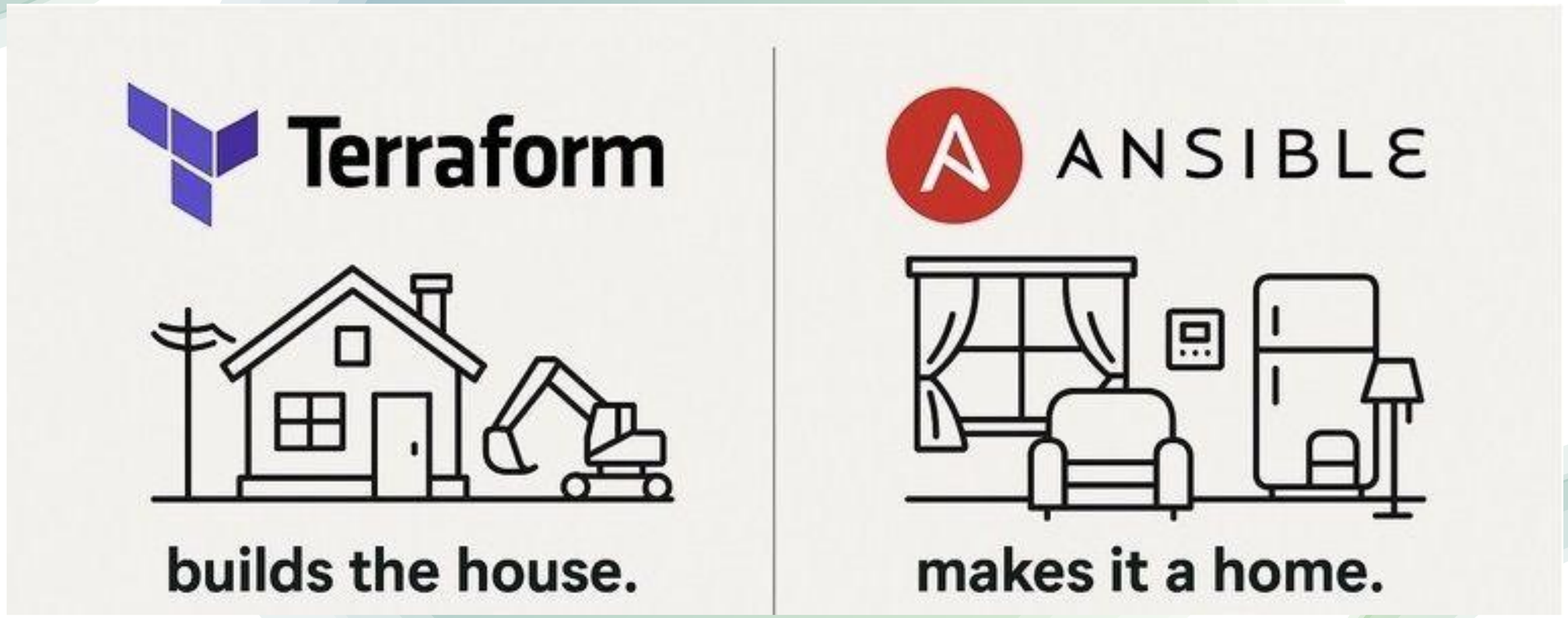
Terraform vs Ansible



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Terraform vs Ansible

Feature	Terraform	Ansible
Primary Focus	Infrastructure provisioning and lifecycle management	Configuration management and application deployment
Approach	Declarative (specifies the desired end state)	Procedural (defines steps to reach the desired state)
State Management	Maintains a state file to track infrastructure changes	Does not maintain a state file, relies on idempotent tasks
Language	HCL (HashiCorp Configuration Language)	YAML (human-readable syntax for tasks)
Execution Method	Push-based (initiates changes from a central point)	Push-based (initiates changes from a central point)
Cloud vs. On-Premises	Optimized for cloud infrastructure lifecycle management	Effective for both cloud and on-premises configuration
Modules/Templates	Modules for reusable IaC components	Playbooks and roles for reusable configurations

Course URLs

Repository Used For	Repository URL
Training GitHub Repository	https://github.com/salehmiri90/terraform-course.git
Terraform Website	https://developer.hashicorp.com/terraform
Terraform Providers	https://registry.terraform.io/
Terraform Providers vSphere	https://github.com/hashicorp/terraform-provider-vsphere

Terraform Providers

Core focus will be on mastering Terraform Concepts with Sample Demo’s

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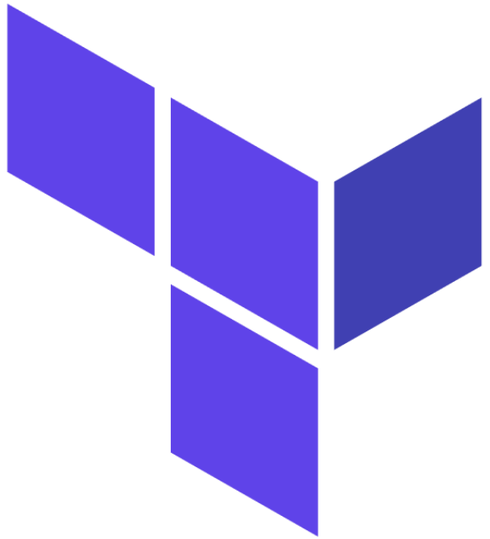
02 : Terraform Architecture

- **Terraform Directory Structure**
- **Terraform Installation Methods**
- **Terraform Basic Commands**
- **Terraform Workflow**
- **Our first Demo**



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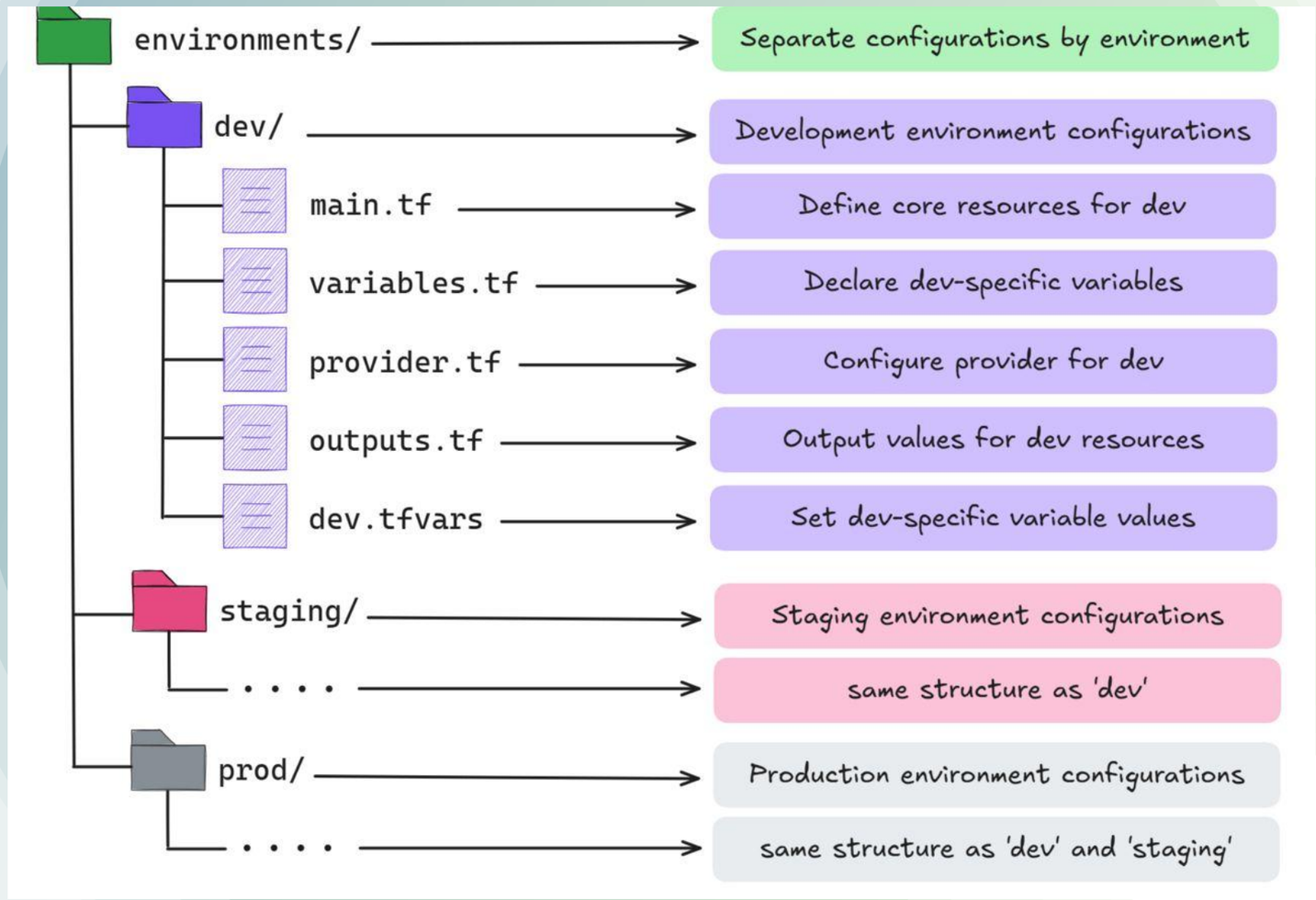
Terraform Directory Structure



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Terraform Installation Methods

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Terraform Basic Commands

- terraform init
- terraform validate
- terraform plan
- terraform apply
- terraform destroy

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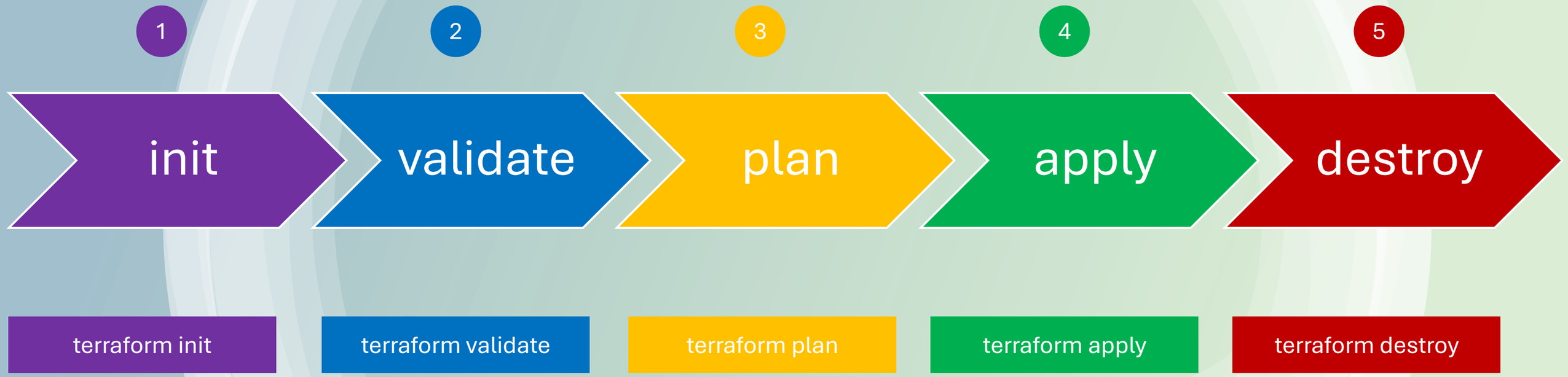
Terraform Workflow



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Terraform Workflow

- Initialize a working directory containing terraform config files
- This is the first command that should be run after writing a new Terraform configuration
- Downloads Providers

- Validates the terraform configurations files in that respective directory to ensure they are syntactically valid and internally consistent.

- Creates an execution plan
- Terraform performs a refresh and determines what actions are necessary to achieve the desired state specified in configuration files

- Used to apply the changes required to reach the desired state of the configuration.
- By default, apply scans the current directory for the configuration and applies the changes appropriately.

- Used to destroy the Terraform-managed infrastructure
- This will ask for confirmation before destroying.

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First Session (click here)

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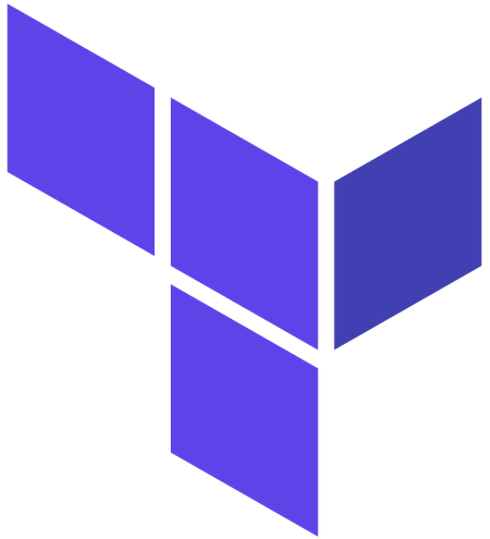
02-3 : Terraform Language Syntax

- Terraform Language Basics – Files
- Terraform Language Basics – Configuration Syntax
- Terraform Top-Level Blocks
- Demo



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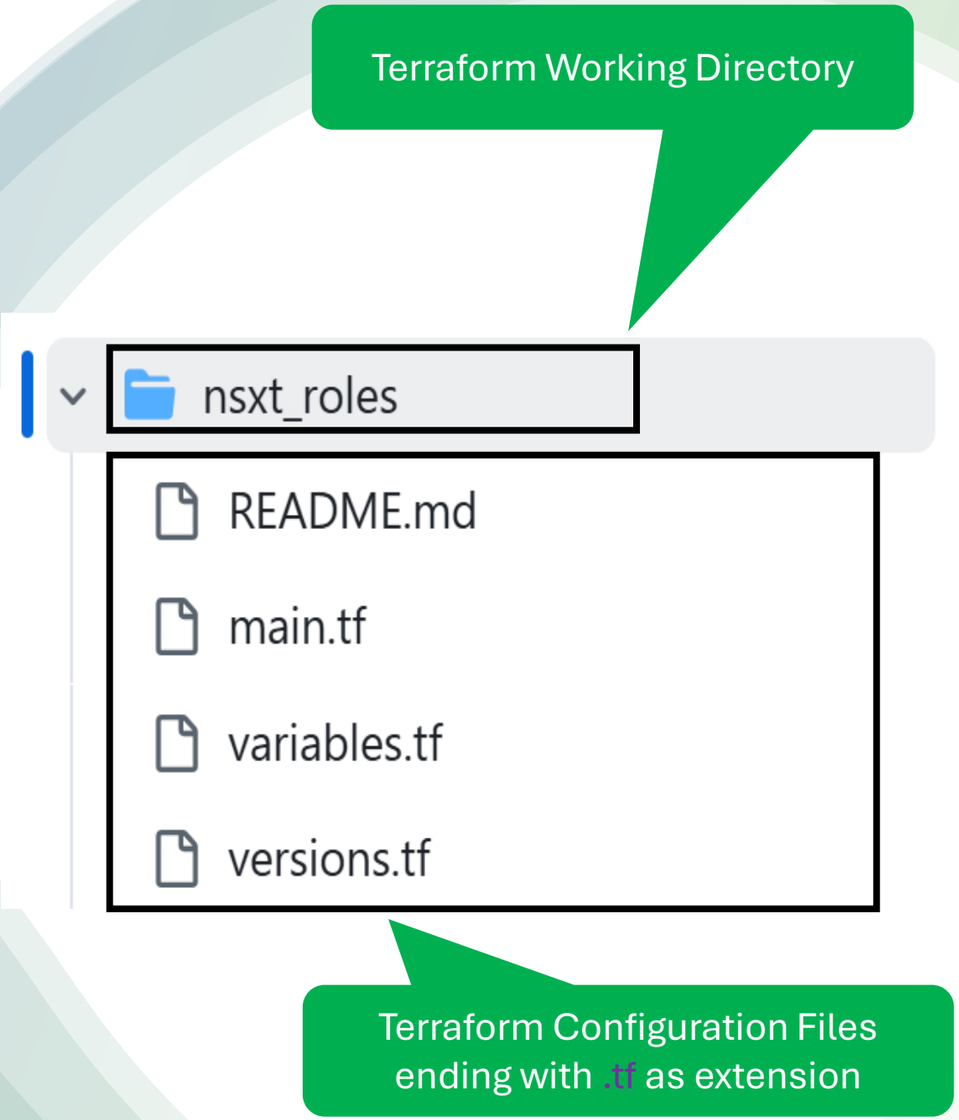
Terraform Language Basics – Files

- Code in the Terraform language is stored in plain text files with the .tf file extension.
- There is also a JSON-based variant of the language that is named with the .tf.json file extension.
- We can call the files containing terraform code as Terraform Configuration Files or Terraform Manifests



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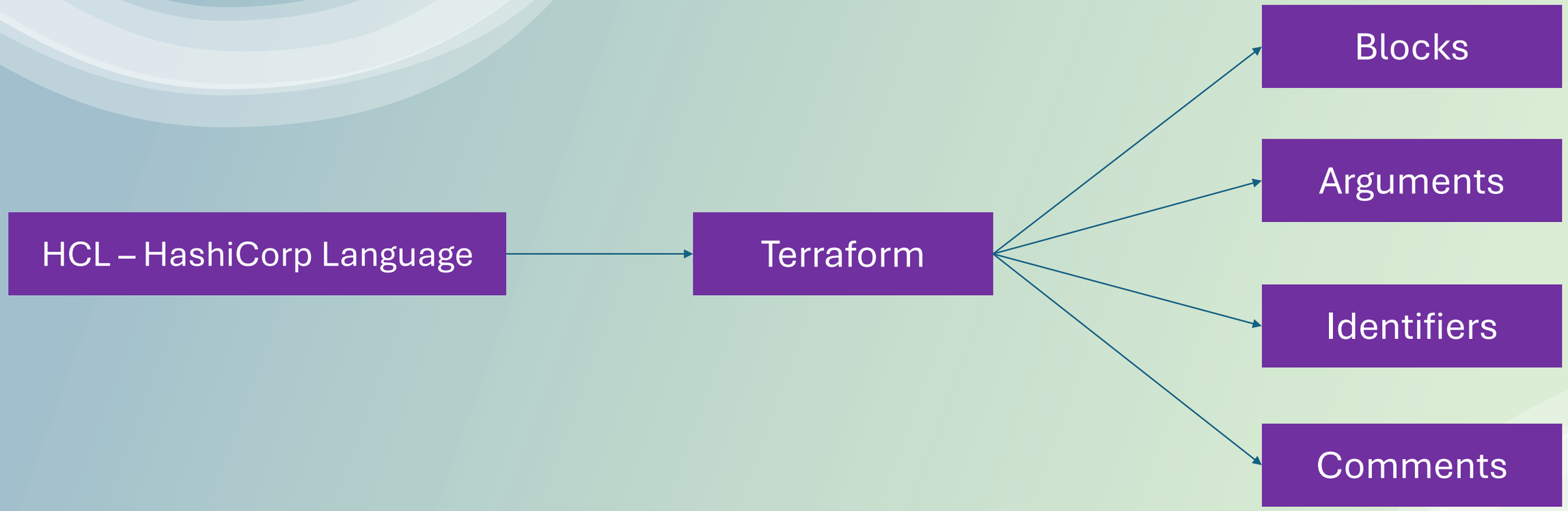
Terraform Language Basics – Configuration Syntax



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Terraform Language Basics – Configuration Syntax

```
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>" {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}
```

Block Type

Block Labels

```
resource "esxi_guest" "vmsalehmiri01" {
  guest_name = "vmsalehmiri01"
  disk_store = "DS_001"
}
```

Top Level & Block inside Blocks

Arguments

Based on Block Type block labels will be 1 or 2
Example: Resource – 2 labels
Variables – 1 label

Top Level Blocks: resource, provider

Block Inside Block: provisioners, resource specific blocks like tags

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Terraform Language Basics – Configuration Syntax

```
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>" {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}
```

```
resource "esxi_guest" "vmsalehmiri01" {
  guest_name = "vmsalehmiri01"
  disk_store = "DS_001"
}
```

Argument Name or Identifier

Argument Value or Expression

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Terraform Language Basics – Configuration Syntax

Single Line Comments with # or //

Multi-line comment

```
# EC2 Instance Resource
resource "aws_instance" "ec2demo" {
  ami           = "ami-0885b1f6bd170450c" // Ubuntu 20.04 LTS
  instance_type = "t2.micro"
  /*
  Multi-line comments
  Line-1
  Line-2
  */
}
```

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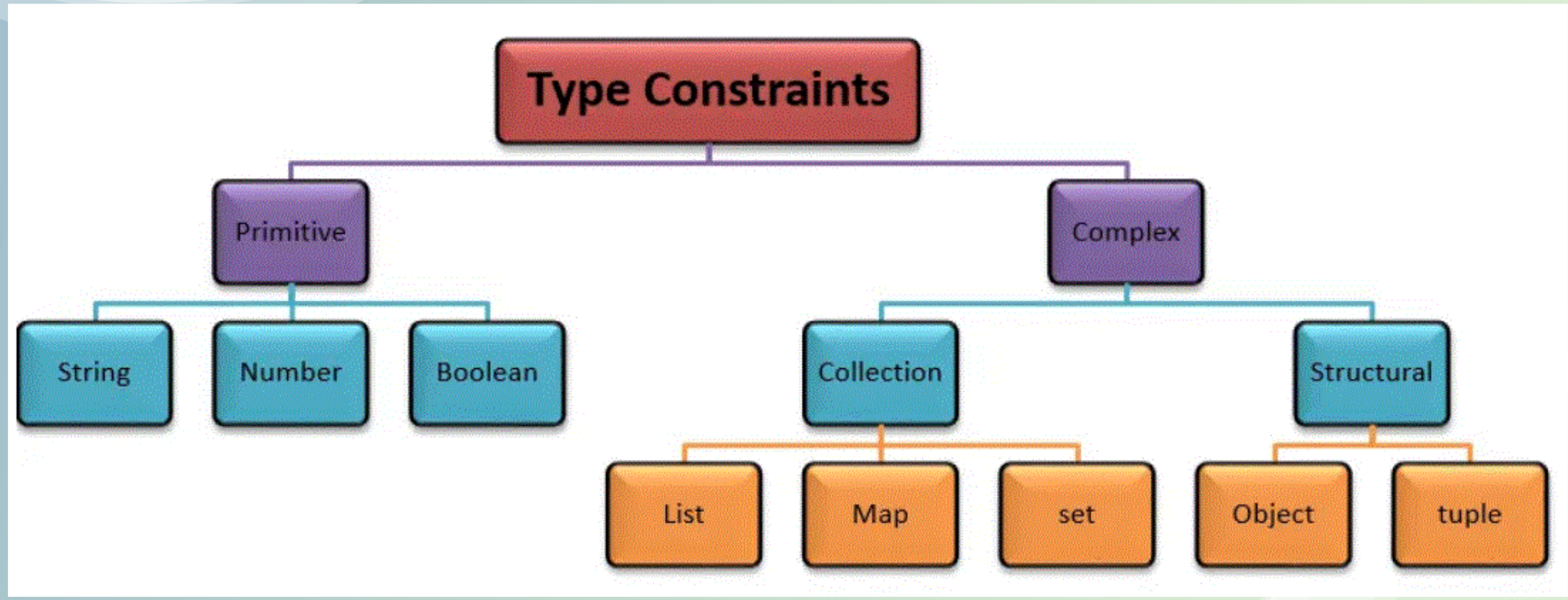
Terraform Language Basics – Configuration Syntax



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List

variables.tf

```
variable "prefix" {
  default = ["Mr", "Mrs", "Sir"]
  type = list  0      1       2
}
```

maint.tf

```
resource "random_pet" "my-pet" {
  prefix     = var.prefix[0]
```

Index	Value
0	Mr
1	Mrs
2	Sir

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Map

variables.tf

```
variable file-content {
  type        = map
  default     = {
      "statement1" = "We love pets!"
      "statement2" = "We love animals!"
  }
 }
```

maint.tf

```
resource local_file my-pet {
  filename  = "/root/pets.txt"
  content = var.file-content["statement2"]
}
```

Key	Value
statement1	We love pets!
statement2	We love animals!

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Terraform Language Basics – Configuration Syntax

Term	Definition	Examples in Code
Arguments	Input parameters configuring the resource	`name`, `num_cpus`, `memory`, `network_interface`, `clone`, `connection` blocks
Attributes	Output/read-only properties of created resource	`self.default_ip_address`
Meta-arguments	Special arguments controlling resource behavior	`dynamic "disk"` with `for_each` and `content`

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Terraform Language Basics – Configuration Syntax

Meta-Argument	Purpose	Example
`count`	Create multiple instances of a resource using a numeric value.	`count = 3` creates 3 identical VMs.
`for_each`	Create multiple instances using a map/set of strings (better than `count` for non-sequential resources).	`for_each = toset(["web", "db"])` creates resources named `web` and `db`.
`depends_on`	Explicitly define dependencies between resources.	`depends_on = [vsphere_folder.parent_folder]` waits for folder creation.
`lifecycle`	Customize how Terraform manages resource lifecycle.	`prevent_destroy = true` blocks accidental deletion.
`provider`	Specify non-default provider configurations.	`provider = vsphere.eu_west` uses a Europe-West vSphere configuration.

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Terraform language uses a limited number of **top-level block** types, which are **blocks** that can appear outside of any other **block** in a TF configuration file.

Terraform Top-Level Blocks

Most of **Terraform's features** are implemented as **top-level** blocks.

Fundamental Blocks

- Terraform Block
- Providers Block
- Resources Block

Variable Blocks

- Input Variables Block
- Output Values Block
- Local Values Block

Calling / Referencing Blocks

- Data Sources Block
- Modules Block

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2nd Session (click here)

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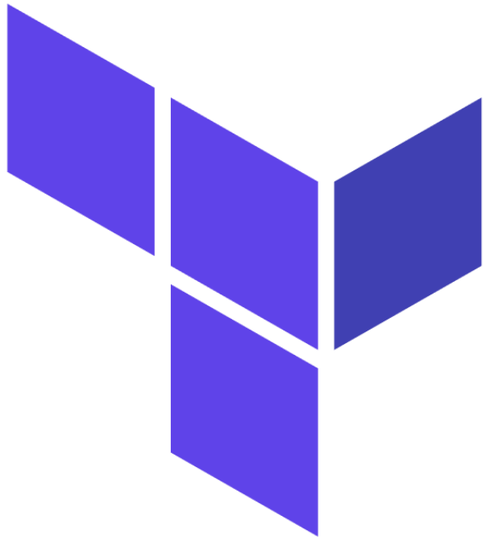
03 : Terraform Fundamental Blocks

- **Terraform Basic Blocks**
- **Terraform Blocks**
- **Demo**



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Terraform Basic Blocks

Terraform Block

- Special block used to configure some behaviors
- Specifying a required Terraform Version
- Specifying Provider Requirements
- Configuring a Terraform Backend (Terraform State)

Provider Block

- HEART of Terraform
- Terraform relies on providers to interact with Remote Systems
- Declare providers for Terraform to install providers & use them
- Provider configurations belong to Root Module

Resource Block

- Each Resource Block describes one or more Infrastructure Objects
- Resource Syntax: How to declare Resources?
- Resource Behavior: How Terraform handles resource declarations?
- Provisioners: We can configure Resource post-creation actions

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Terraform Block

- This block can be called in 3 ways. All means the same.
  - Terraform Block
  - Terraform Settings Block
  - Terraform Configuration Block
- Each terraform block can contain a number of settings related to Terraform's behavior.
- Within a terraform block, only constant values can be used; arguments may not refer to named objects such as resources, input variables, etc, and may not use any of the Terraform language built-in functions.

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Terraform Block from 0.13 onwards

Terraform 0.12 and earlier:

```
# Configure the AWS Provider
provider "aws" {
  version = "~> 3.0"
  region  = "us-east-1"
}

# Create a VPC
resource "aws_vpc" "example" {
  cidr_block = "10.0.0.0/16"
}
```

Terraform 0.13 and later:

```
terraform {
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 3.0"
    }
  }
}

# Configure the AWS Provider
provider "aws" {
  region = "us-east-1"
}

# Create a VPC
resource "aws_vpc" "example" {
  cidr_block = "10.0.0.0/16"
}
```

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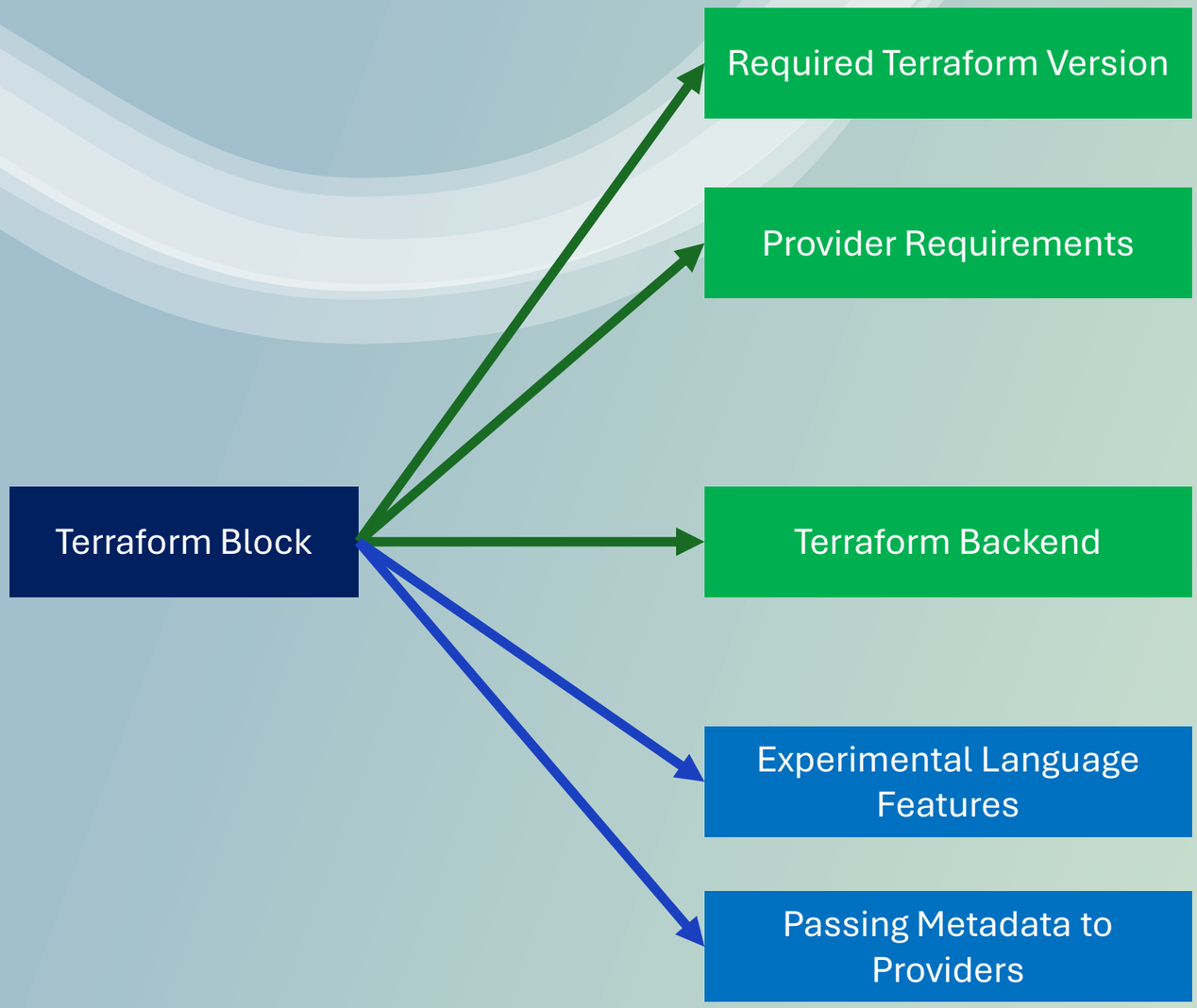
Terraform Block




```hcl
terraform {
  # Required Terraform Version
  required_version = "~> 0.14.3"
  # Required Providers and their Versions
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 3.21" # Optional but recommended
    }
  }
  # Remote Backend for storing Terraform State in S3 bucket
  backend "s3" {
    bucket = "mybucket"
    key    = "path/to/my/key"
    region = "us-east-1"
  }
  # Experimental Features (Not required)
  experiments = [ example ]
  # Passing Metadata to Providers (Super Advanced - Terrafor
  provider_meta "my-provider" {
    hello = "world"
  }
}
```

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3rd Session (click here)

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03-2: Terraform Providers

- Terraform Providers
- Dependency Lock File
- Required Providers
- Terraform Registry
- Terraform Registry
- Demo

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Terraform Providers

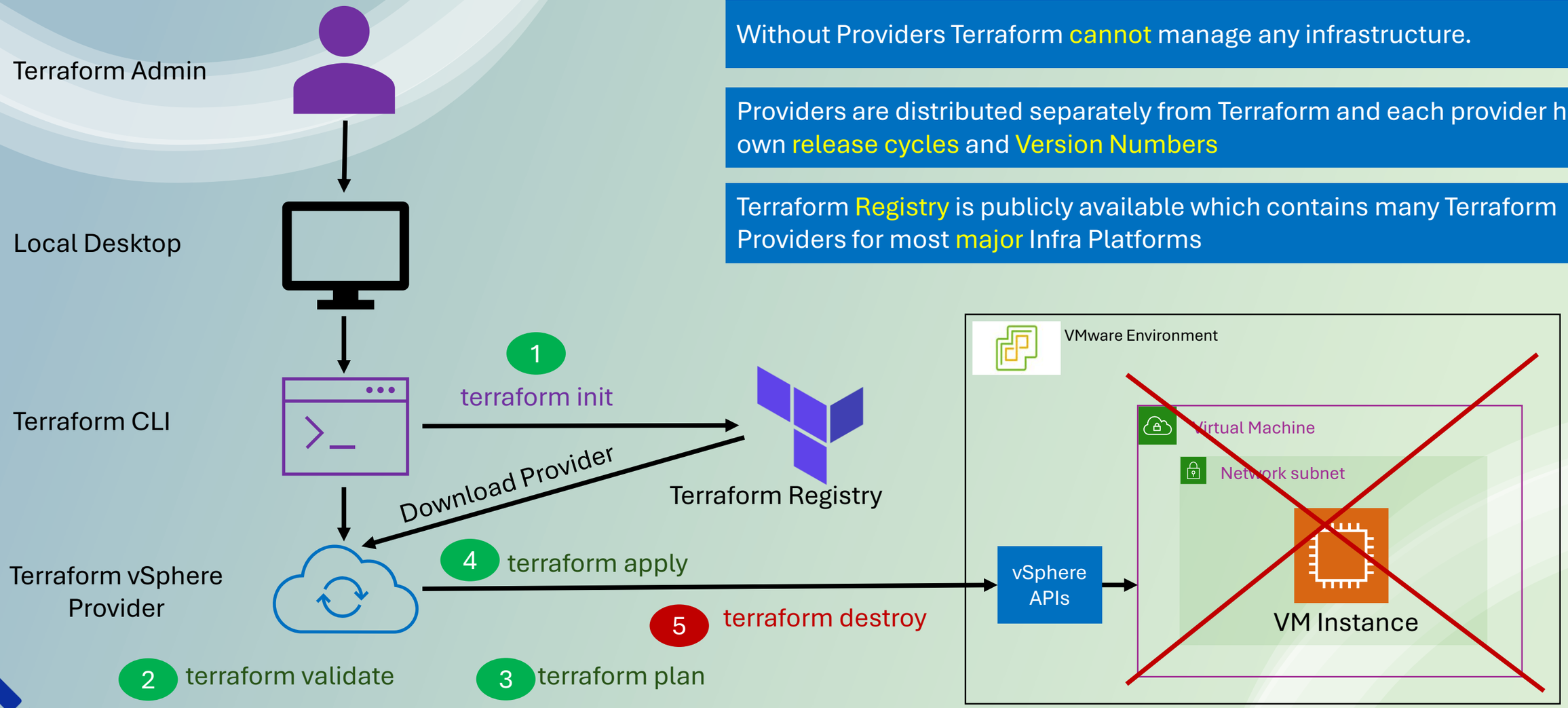
Providers are HEART of Terraform

Every Resource Type (example: VM, EC2), is implemented by a Provider

Without Providers Terraform cannot manage any infrastructure.

Providers are distributed separately from Terraform and each provider has its own release cycles and Version Numbers

Terraform Registry is publicly available which contains many Terraform Providers for most major Infra Platforms



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Terraform Providers

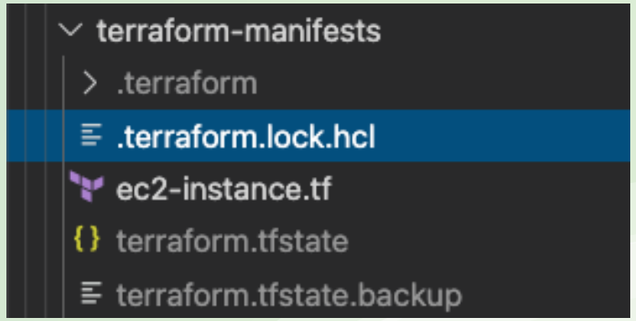
Provider Requirements

```
# Terraform Settings Block
terraform {
  required_version = "~> 1.8.0"
  required_providers {
    vsphere = {
      source  = "hashicorp/vsphere"
      version = "2.8.1"
    }
  }
}
```

Provider Configuration

```
# Provider Block
provider "vsphere" {
  user                 = "administrator@vsphere.local"
  password             = "P@ssw0rd"
  vsphere_server       = "1.2.3.4"
  allow_unverified_ssl = true
}
```

Dependency Lock File




```
# This file is maintained automatically by "terraform init".
# Manual edits may be lost in future updates.

provider "registry.terraform.io/hashicorp/aws" {
  version = "3.22.0"
  hashes = [
    "h1:f/Tz8zv1Zb78ZaiyJkQ0MGIViZwbYrLuQk3kojPM91c=",
    "zh:4a9a66caf1964cdd3b61fb3ebb0da417195a5529cb8e496f266b0778335d11c8",
    "zh:514f2f006ae68db715d86781673faf9483292deab235c7402ff306e0e92ea11a",
    "zh:5277b61109fddb9011728f6650ef01a639a0590aeffe34ed7de7ba10d0c31803",
    "zh:67784dc8c8375ab37103eea1258c3334ee92be6de033c2b37e3a2a65d0005142",
    "zh:76d4c8be2ca4a3294fb51fb58de1fe03361d3bc403820270cc8e71a04c5fa806",
    "zh:8f90b1cfdcf6e8fb1a9d0382ecaa5056a3a84c94e313fbf9e92c89de271cdede",
    "zh:d0ac346519d0df124df89be2d803eb53f373434890f6ee3fb37112802f9eac59",
    "zh:d6256feedada82cbfb3b1dd6dd9ad02048f23120ab50e6146a541cb11a108cc1",
    "zh:db2fe0d2e77c02e9a74e1ed694aa352295a50283f9a1cf896e5be252af14e9f4",
    "zh:eda61e889b579bd90046939a5b40cf5dc9031fb5a819fc3e4667a78bd432bdb2",
  ]
}
```

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Provider Requirements

```hcl
# Terraform Settings Block
terraform {
  required_version = "~> 1.8.0"
  required_providers {
    vsphere = {
      source  = "hashicorp/vsphere"
      version = "2.8.1"
    }
  }
}
```

```hcl
# Provider Block
provider "vsphere" {
  user                 = "administrator@vsphere.local"
  password             = "P@ssw0rd"
  vsphere_server       = "1.2.3.4"
  allow_unverified_ssl = true
}
```

Local Names

- Local Names are Module specific and should be unique per-module
- Terraform configurations always refer to local name of provider outside required_provider block
- Users of a provider can choose any local name for it (myvsphere, vsphere1, vsphere2, provider1)
- Recommended way of choosing local name is to use preferred local name of that provider (For vSphere Provider: hashicorp/vsphere, preferred local name is vsphere)

Source

- It is the primary location where we can download the Terraform Provider
- Source addresses consist of three parts delimited by slashes (/)
- [<HOSTNAME>/]<NAMESPACE>/<TYPE>
- registry.terraform.io/hashicorp/vsphere
- Registry Name is optional as default is going to be Terraform Public Registry

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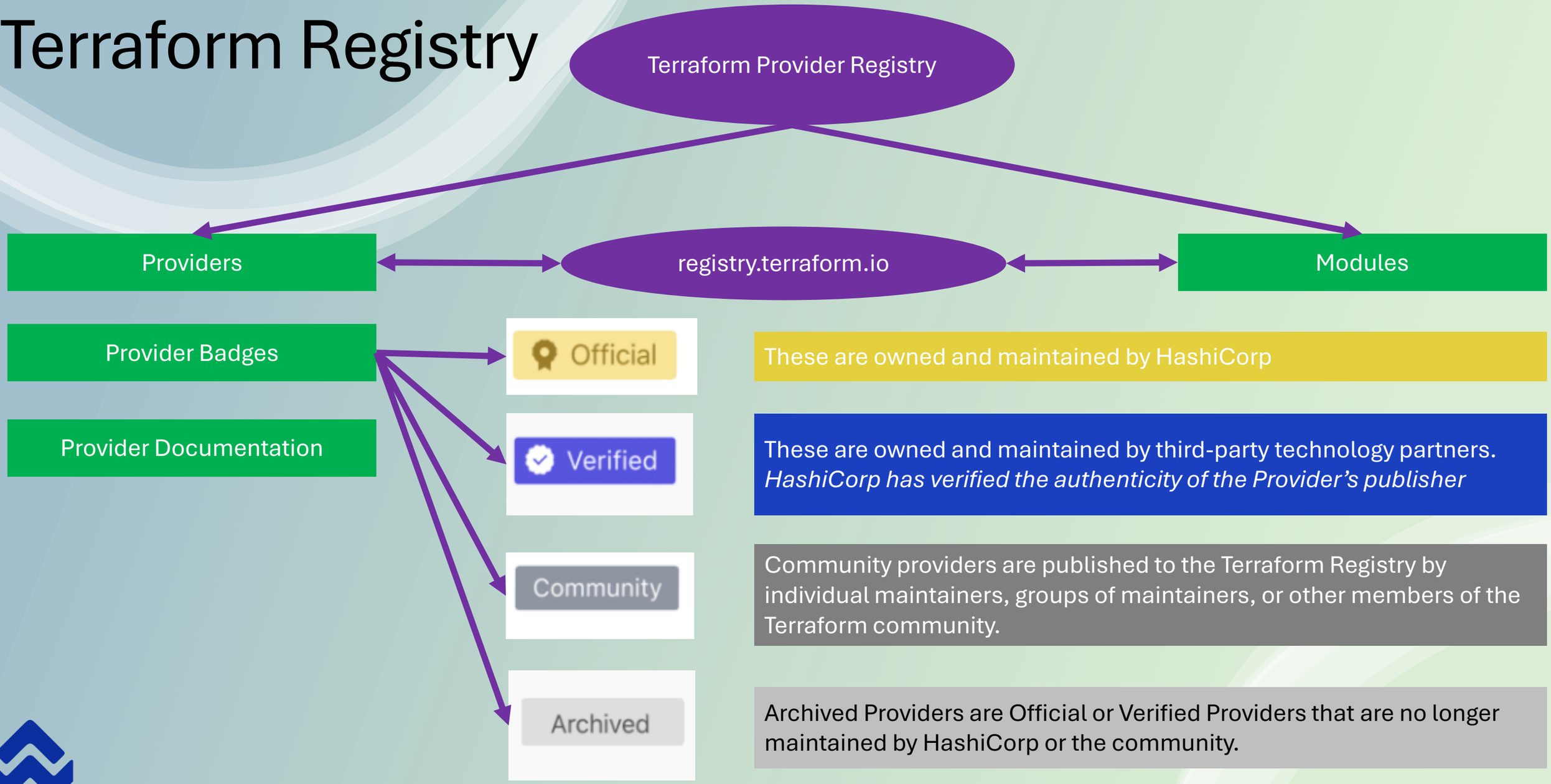
Terraform Registry



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Dependency Lock File

This feature added from Terraform v0.14 & later

Version Constraints within the configuration itself determine which versions of dependencies are *potentially* compatible

Dependency Lock File: After selecting a specific version of each dependency using Version Constraints Terraform remembers the decisions it made in a dependency lock file so that it can (by default) make the same decisions again in future.

Location of Lock File: Current Working Directory

Very Important: Lock File currently tracks only Provider Dependencies.

Checksum Verification: Terraform will also verify that each package it installs matches at least one of the checksums it previously recorded in the lock file, if any, returning an error if none of the checksums match

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Multiple Providers

We can define multiple configurations for the same provider, and select which one to use on a per-resource or per-module basis.

The primary reason for this is to support multiple regions for a cloud platform

We can use the alternate provider in a resource, data or module by referencing it as <PROVIDER NAME>.<ALIAS>

```
# Provider-1 for vcenter1 (Default Provider)
provider "vsphere" {
  user                 = "administrator@vsphere.local"
  password             = "P@ssw0rd"
  vsphere_server       = "1.2.3.4"
  allow_unverified_ssl = true
}

# Provider-2 for vcenter2
provider "vsphere" {
  user                 = "sre@vsphere.local"
  password             = "1404AdvancePass"
  vsphere_server       = "11.12.13.14"
  allow_unverified_ssl = true
  alias = "cluster2"
}
```

```
# Resource Block to Create VM in vcenter2
resource "vsphere_virtual_machine" "resource2_vm" {
  name     = "resource2_vm"
  #<PROVIDER NAME>.<ALIAS>
  provider = vsphere.cluster2
}
```

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4th Session (click here)

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04 : Terraform Resources

- Terraform Language Basics
- Terraform Resource Syntax
- Terraform Resource Behavior
- Terraform State
- Meta-Argument count
- Meta-Argument depends_on
- Meta-Argument for_each
- Meta-Argument lifecycle
- Demo

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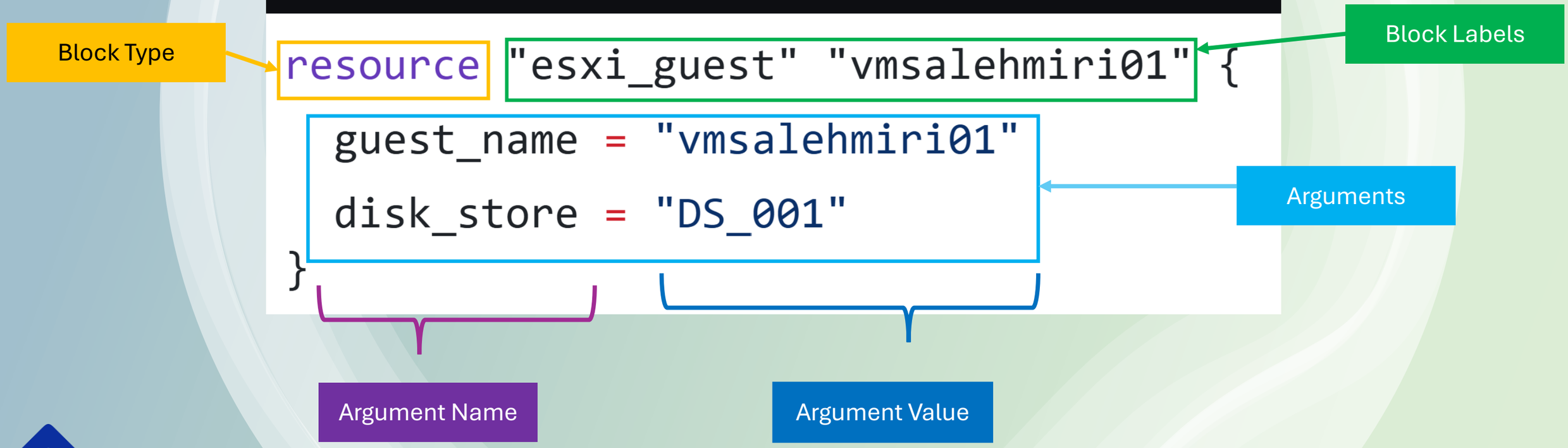
Terraform Language Basics – Configuration Syntax

```
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>" {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}
```



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Resource Syntax

Resource Type: It determines the kind of infrastructure object it manages and what arguments and other attributes the resource supports.

Resource Local Name: It is used to refer to this resource from elsewhere in the same Terraform module, but has no significance outside that module's scope.
The resource type and name together serve as an identifier for a given resource and so must be unique within a module

Meta-Arguments: Can be used with any resource to change the behavior of resources

Resource Arguments: Will be specific to resource type. Argument Values can make use of Expressions or other Terraform Dynamic Language Features

```
# Provider Block
provider "vsphere" {
  user                 = "administrator@vsphere.local"
  password             = "P@ssw0rd"
  vsphere_server       = "1.2.3.4"
  allow_unverified_ssl = true
  alias = "cluster2"
}

# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {

  provider = vsphere.cluster2

  name             = "saleh-vm"
  datastore_id     = data.vsphere_datastore.ds.id
  num_cpus = 4
  memory   = 4096
  #...
```

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Resource Behavior

Terraform State

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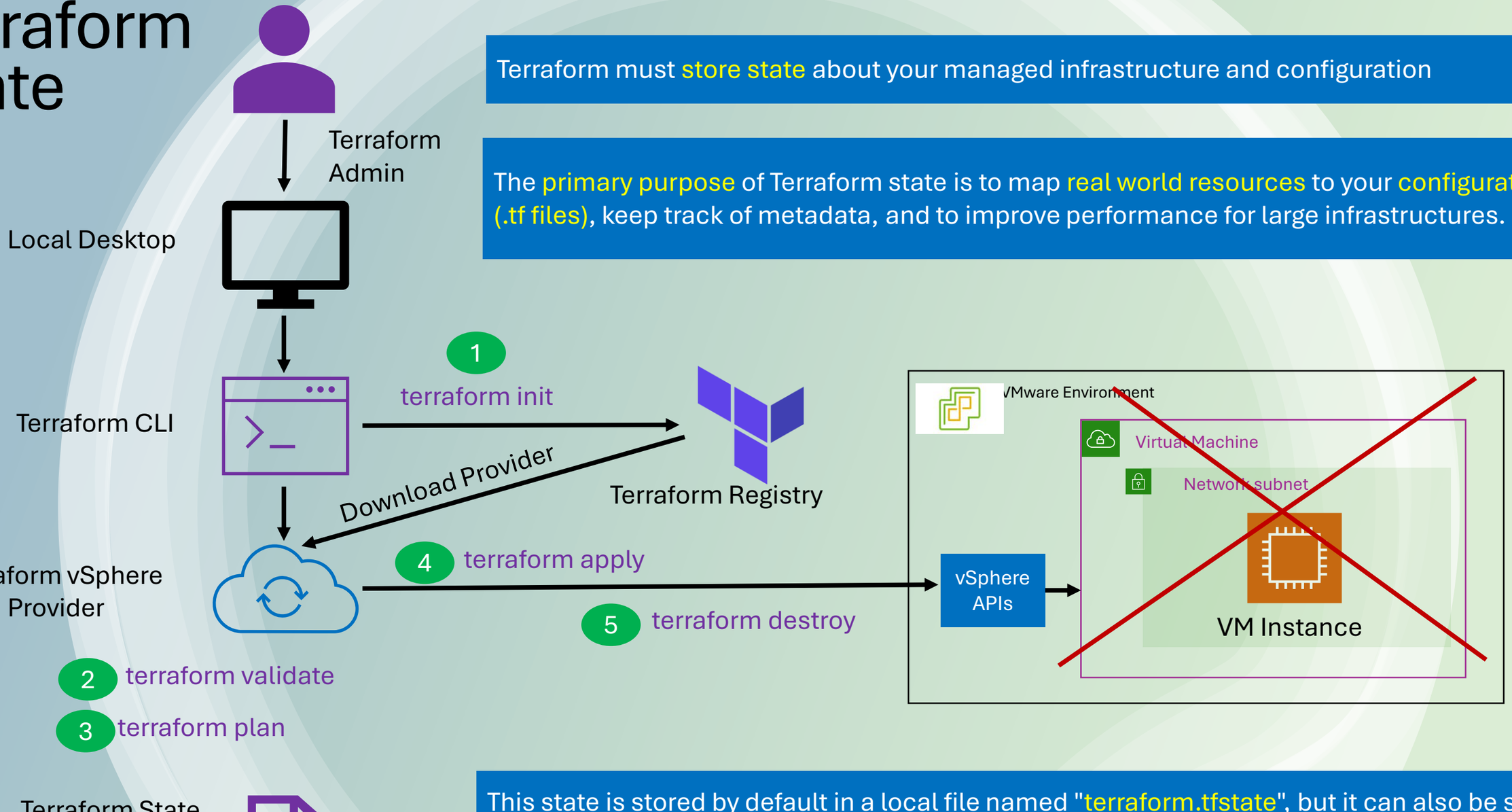
Terraform State

Terraform must store state about your managed infrastructure and configuration

The primary purpose of Terraform state is to map real world resources to your configuration (.tf files), keep track of metadata, and to improve performance for large infrastructures.



This state is stored by default in a local file named "terraform.tfstate", but it can also be stored remotely, which works better in a team environment.

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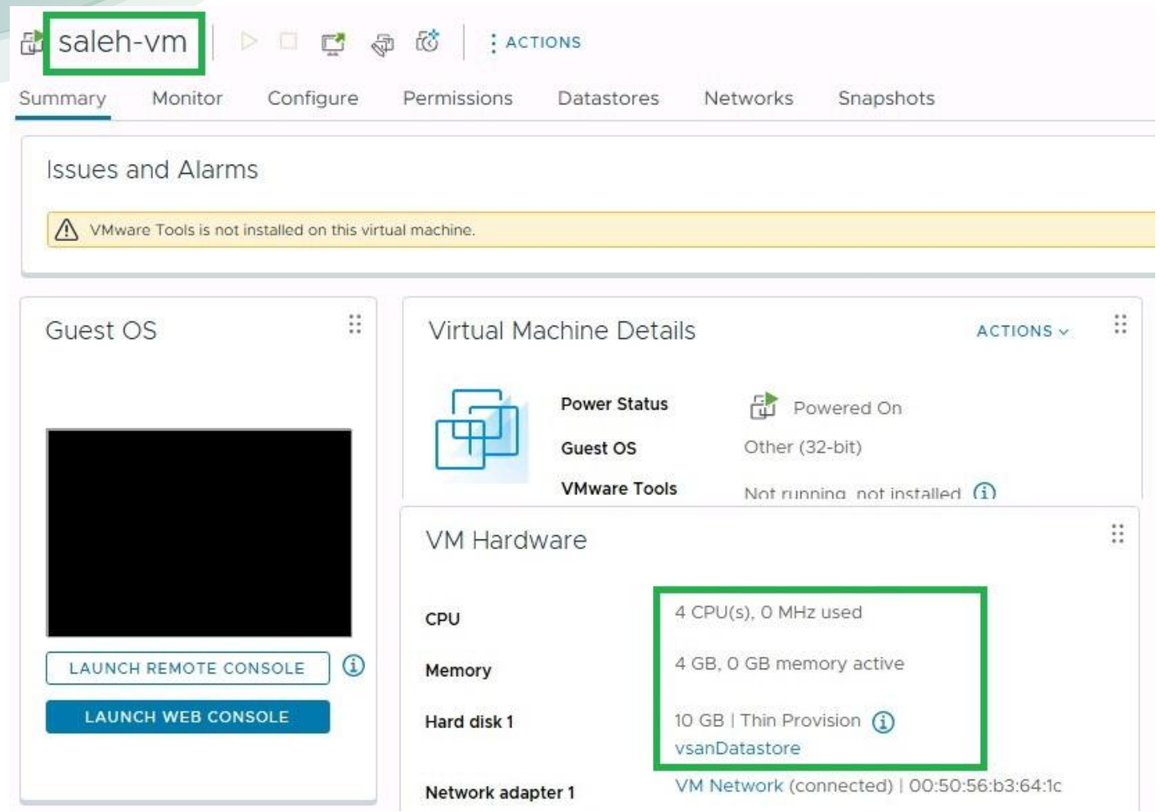
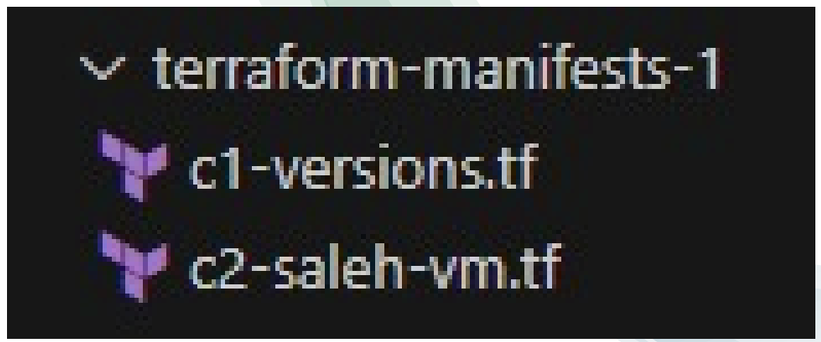
Desired & Current Terraform States

Real World Resource – VM Instance



Current State

Terraform Configuration Files



Desired State

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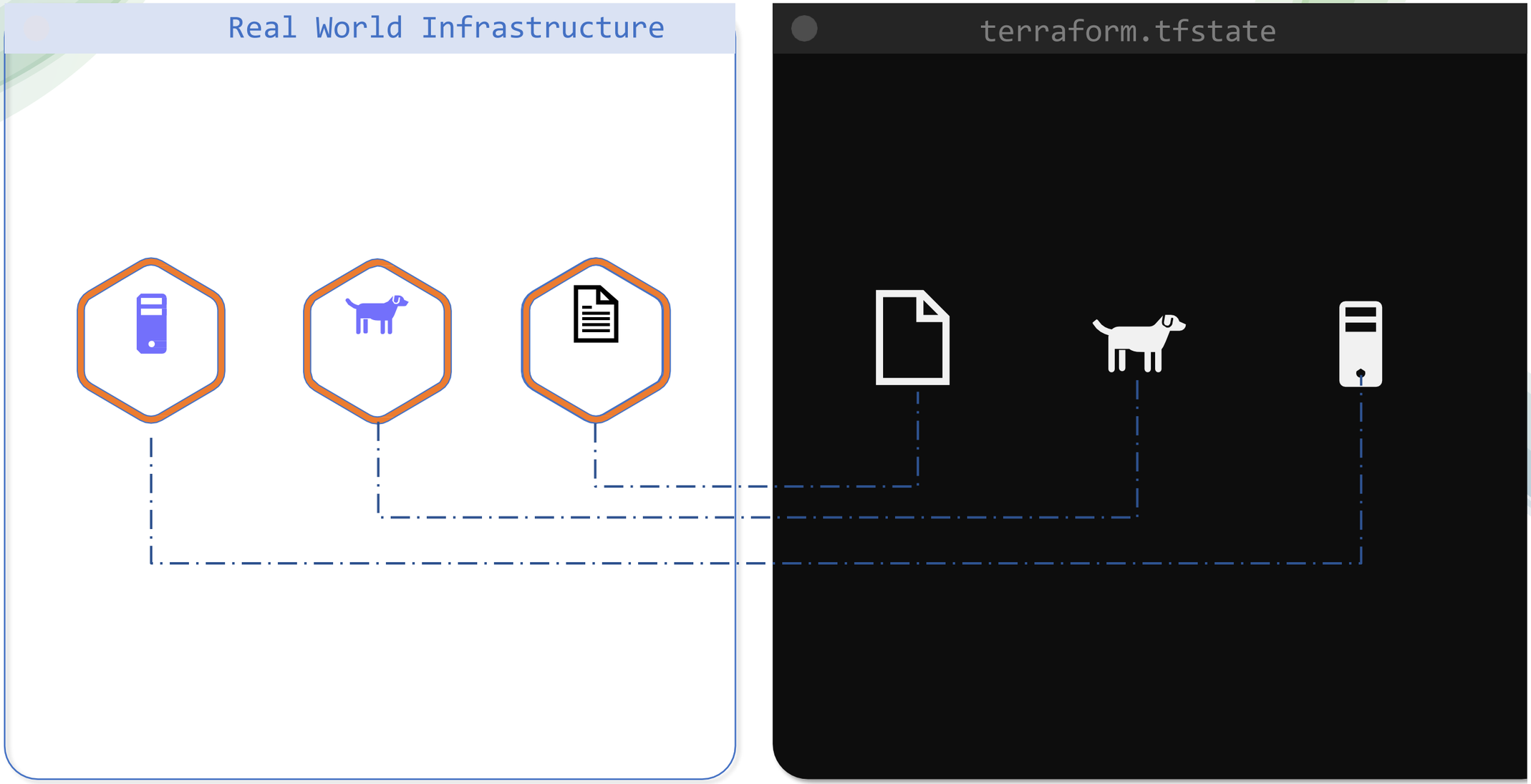
Real World Infrastructure
terraform.tfstate

variables.tf

```
variable "filename" {
  default = "/root/pets.txt"
}
variable "content" {
  default = "We love pets!"
}
```

>_

```
$ terraform plan
Refreshing Terraform state in-memory
prior to plan...
The refreshed state will be used to
calculate this plan, but will not be
persisted to local or remote state
storage.

local_file.pet: Refreshing state...
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e
1b68]
.
.
.
[Output Truncated ]
```

>_

```
[terraform-local-file]$ cat  terraform.tfstate
{
  "version": 4,
  "terraform_version": "0.13.0",
  "serial": 1,
  "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31"
  "outputs": {},
  "resources": [
    {
      "mode": "managed",
      "type": "local_file",
      "name": "pet",
      "provider":
"provider[\"registry.terraform.io/hashicorp/local\"
      "instances": [
        {
          "schema_version": 0,
          "attributes": {
            "content": "I love pets!",
            "content_base64": null,
            "directory_permission": "0777",
            "file_permission": "0777",
            "filename": "/root/pets.txt",
            "id":
"7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68",
            "sensitive_content": null
          },
          "private": "bnVsbA=="
```

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5th Session (click here)

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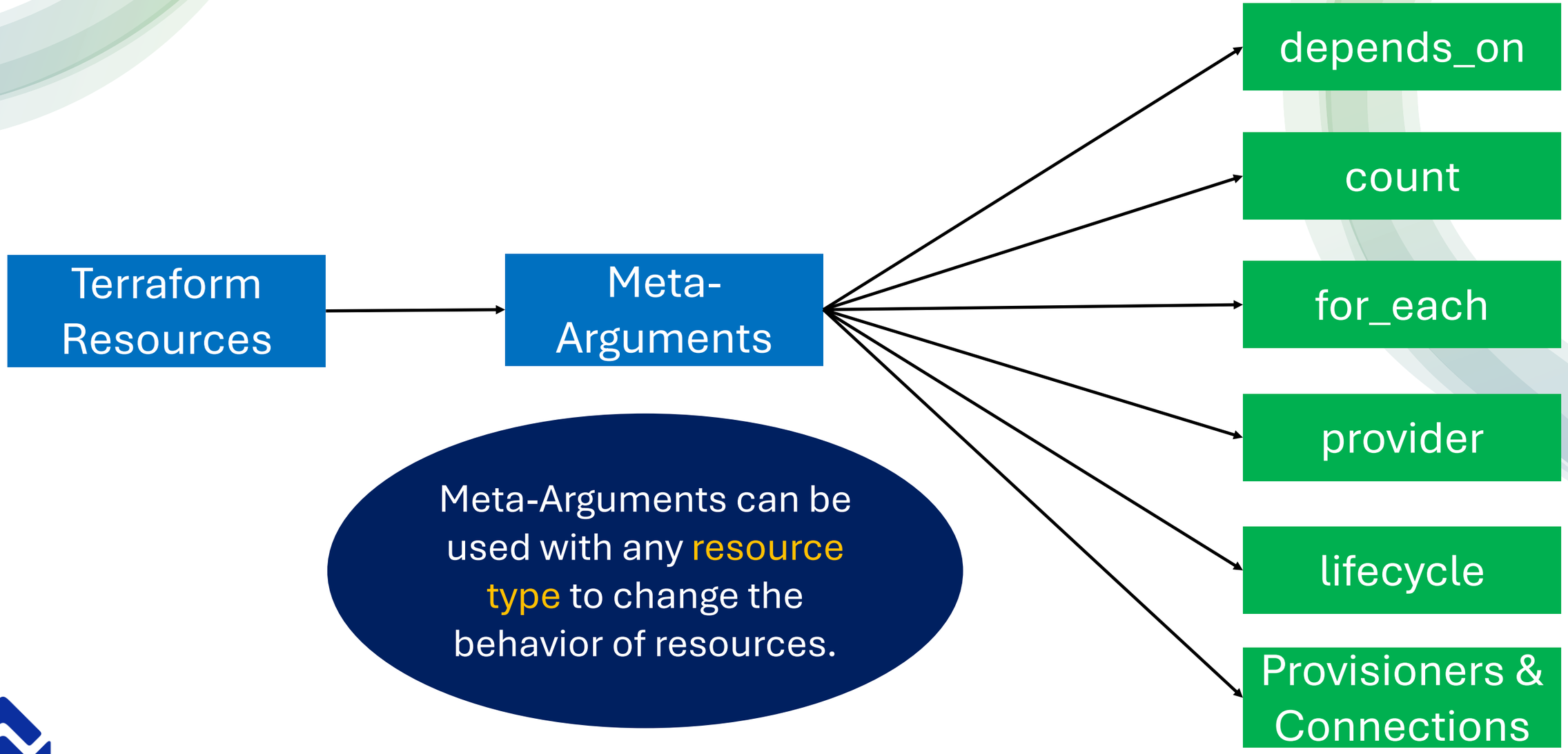
Resource Meta-Arguments



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Resource Meta-Arguments

depends_on	Explicitly defines dependencies between resources to control the creation order.
count	Creates multiple instances of a resource based on the given number.
for_each	Creates multiple instances of a resource using a map or set of strings as input.
provider	Specifies which provider configuration to use for a resource.
lifecycle	Configures how Terraform handles resource creation, update, and deletion.
Provisioners	Executes scripts or commands on a local or remote machine during resource creation or destruction.
Connections	Defines how Terraform connects to the resource for provisioning (e.g., SSH or WinRM).

Resource Meta-Arguments – depends_on

Use the depends_on meta-argument to handle hidden resource or module dependencies that Terraform can't automatically infer.

Explicitly specifying a dependency is only necessary when a resource or module relies on some other resource's behavior but *doesn't* access any of that resource's data in its arguments.

This argument is available in module blocks and in all resource blocks, regardless of resource type.

Resource Meta-Argument depends_on

The depends_on meta-argument, if present, must be a list of references to other resources or child modules in the same calling module.

Arbitrary expressions are not allowed in the depends_on argument value, because its value must be known before Terraform knows resource relationships and thus before it can safely evaluate expressions.

The depends_on argument should be used only as a last resort. Add comments for future reference about why we added this.

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Use case: What are we going implement?

Scenario:
create a virtual machine with Terraform in vSphere only if a custom folder (named `saleh-folder`) already exists.

Resource-1: Create a resource for vSphere Folder

Use depends_on to set an explicit dependency on mentioned Folder

Resource-2: Create VM depends_on

Resource-2: Create VM Instance in the selected Folder

```
resource "vsphere_virtual_machine" "saleh_vm" {
  name             = "saleh-vm"
  folder      = vsphere_folder.saleh_folder.path
  depends_on = [vsphere_folder.saleh_folder]
  resource_pool_id = data.vsphere_compute_cluster.
  datastore_id     = data.vsphere_datastore.ds.id

  num_cpus = 4
  memory   = 4096
```

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Resource Meta-Arguments – count

If a resource or module block includes a count argument whose value is a whole number, Terraform will create that many instances.

count.index: The distinct index number (starting with 0) corresponding to this instance.

Each instance has a distinct infrastructure object associated with it, and each is separately created, updated, or destroyed when the configuration is applied.

Resource Meta-Argument count

When count is set, Terraform distinguishes between the block itself and the multiple resource or module instances associated with it. Instances are identified by an index number, starting with 0.
vsphere_virtual_machine.saleh_vm[0]

The count meta-argument accepts numeric expressions. The count value must be known *before* Terraform performs any remote resource actions.

Module support for count was added in Terraform 0.13, and previous versions can only use it with resources.

A given resource or module block cannot use both count and for_each

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Use case: What are we going implement?

Resource-1: Use Meta-Argument Count to create multiple VM Instances using single Resource

```
# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {

  count     = 5
  name      = "saleh-vm-${count.index}"

  num_cpus = 4
  memory   = 4096
```

count

count.index

vsphere_virtual_machine.saleh_vm[0]

vsphere_virtual_machine.saleh_vm[1]

vsphere_virtual_machine.saleh_vm[2]

vsphere_virtual_machine.saleh_vm[3]

vsphere_virtual_machine.saleh_vm[4]

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Resource Meta-Arguments – for_each

If a resource or module block includes a for_each argument whose value is a map or a set of strings, Terraform will create one instance for each member of that map or set.

A given resource or module block cannot use both count and for_each

For set of Strings, each.key = each.value
for_each = toset(["Saleh", "Miri"])
each.key = Saleh
each.key = Miri

Each instance has a distinct infrastructure object associated with it, and each is separately created, updated, or destroyed when the configuration is applied.

Resource Meta-Argument for_each

For Maps, we use each.key & each.value
for_each = {
dev = "my-vm"
}
each.key = dev
each.value = my-vm

In blocks where for_each is set, an additional each object is available in expressions, so you can modify the configuration of each instance.
each.key — The map key (or set member) corresponding to this instance.
each.value — The map value corresponding to this instance. (If a set was provided, this is the same as each.key.)

Module support for for_each was added in Terraform 0.13, and previous versions can only use it with resources.

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for_each vs count

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Usecase-1: for_each Maps

Resource-1: Use Meta-Argument for_each with Maps to create multiple VMs using single Resource

Define for_each with Map with Key Value pairs

Use each.key and each.value for the VM name

Use each.key and each.value for VM disk names


```
# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {
  // added in this section
  for_each = {
    "vm-a" = 5
    "vm-b" = 10
    "vm-c" = 15
    "vm-d" = 20
    "vm-e" = 25
  }
  name     = "saleh-${each.key}"
  disk {
    label            = "saleh-${each.key}-disk0"
    size             = each.value
      eagerly_scrub  = false
    thin_provisioned = true
  }
  //
```

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Usecase-2: for_each Set of Strings (toset)

Resource-1: Use Meta-Argument for_each with Set of Strings to create multiple VMs using single Resource

```
# Variable Block
variable "vm_names" {
  default = ["tosetvm-01", "tosetvm-02", "tosetvm-03"]
}

# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {

  for_each = toset(var.vm_names)
  name     = "saleh-${each.key}"
//
```

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lifecycle is a nested block that can appear within a resource block

Resource Meta-Argument lifecycle

The lifecycle block and its contents are meta-arguments, available for all resource blocks regardless of type.

create_before_destroy

```
data "vsphere_datastore" "ds" {
  // change datastore name from dat
  name          = "vsanDatastore"
  # name          = "datastore2"
  datacenter_id = data.vsphere_data
}

 // added in this section
 lifecycle {
   create_before_destroy = true
 }
 //
```

prevent_destroy

```
# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {
  name      = "saleh-lifecycle2"
  num_cpus = 1
  memory    = 1024
  lifecycle {
    prevent_destroy = true # Default is false
  }
```

ignore_changes

```
# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {
  name      = "saleh-lifecycle3"
  #name      = "saleh-lifecycle3-new"
  lifecycle {
    ignore_changes = [name]
  }
```

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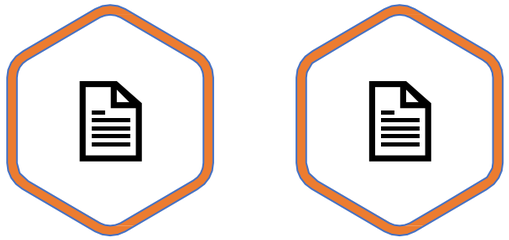
create_before_destroy

main.tf

```
resource "local_file" "pet" {
    filename = "v1-pets.txt"
    content = "We love pets!"
    file_permission = "0700"

    lifecycle  {
        create_before_destroy   = true
    }


}
```



>_

```
$ terraform apply

# local_file.pet must be replaced
-/+ resource "local_file" "pet" {
        content              = "We love pets!"
        directory_permission = "0777"
      ~ file_permission      = "0777" -> "0755" # forces repl
        filename             = "v1-pet.txt"
      ~ id                   =
"5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after ap
    }

Plan: 1 to add, 0 to change, 1 to destroy.

...

local_file.pet: Creating...
local_file.pet: Creation complete after 0s
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]

local_file.pet: Destroying...
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]
local_file.pet: Destruction complete after 0s

Apply complete! Resources: 1 added, 0 changed, 1 destroyed.
```

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prevent_destroy

main.tf

```
resource "local_file" "pet" {
    filename = "v2-pets.txt"
    content = "We love pets!"
    file_permission = "0700"

    lifecycle  {
        prevent_destroy   = true
    }


}
```

>_

```
$ terraform apply
local_file.my-pet: Refreshing state...
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]

Error: Instance cannot be destroyed

  on main.tf line 1:
   1: resource "local_file" "my-pet" {

Resource local_file.my-pet has
lifecycle.prevent_destroy set, but the plan calls
for this resource to be destroyed. To avoid this error
and continue with the plan, either disable
lifecycle.prevent_destroy or reduce the scope of the
plan using the -target flag.
```

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ignore_changes

main.tf

```
resource "local_file" "pet" {
    filename = "v3-pets.txt"
    content = "We love pets!"
    file_permission = "0700"

    lifecycle  {
        ignore_changes = [
            content
        ]
    }
}
```

main.tf

```
resource "local_file" "pet" {
    filename = "v3-pets.txt"
    content = "We love dogs!"
    file_permission = "0700"

    lifecycle  {
        ignore_changes = [
            content
        ]
    }
}
```

>_

```
$ terraform apply

local_file.pet: Refreshing state... [id=i-
05cd83b221911acd5]

Apply complete! Resources: 0 added, 0 changed, 0 destroyed.
```

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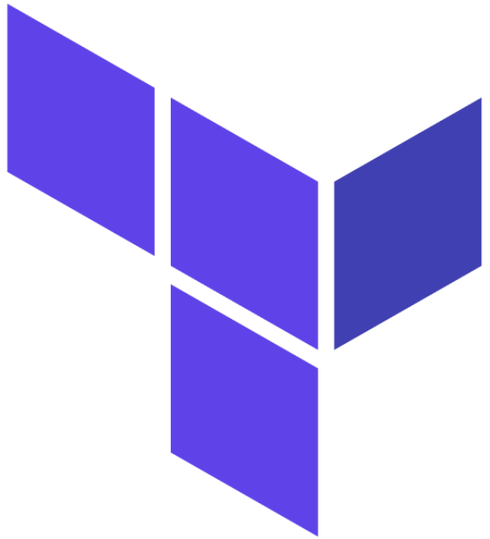
05 : Terraform Variables

- Terraform Input Variables
- Demo
- Terraform Output Values
- Demo
- Terraform Local Values
- DRY
- Demo



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Terraform Variables

Terraform Input Variables

Terraform Output Values

Terraform Local Values

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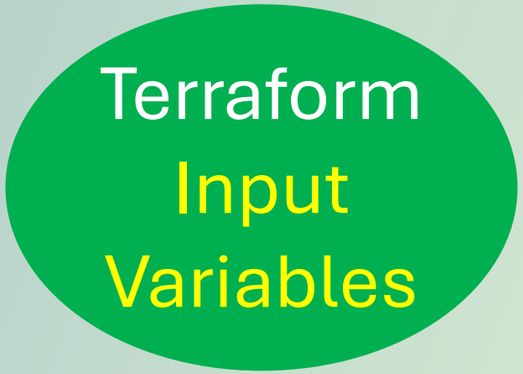
Terraform Input Variables

Input variables serve as parameters for a Terraform module, allowing aspects of the module to be customized without altering the module's own source code, and allowing modules to be shared between different configurations.



1. Input Variables - Basics
2. Provide Input Variables when prompted during terraform plan or apply
3. Override default variable values using CLI argument -var
4. Override default variable values using Environment Variables (TF_var_aa)
5. Provide Input Variables using terraform.tfvars files
6. Provide Input Variables using <any-name>.tfvars file with CLI argument -var-file
7. Provide Input Variables using auto.tfvars files
8. Implement complex type constructors like List & Map in Input Variables
9. Implement Custom Validation Rules in Variables
10. Protect Sensitive Input Variables

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Sample Main File

main.tf

```
resource "local_file" "pet" {
    filename = "/root/pets.txt"
    content = "We love pets!"

}

resource "random_pet" "my-pet" {
    prefix = "Mrs"
    separator = "."
    length = "1"
}
```

variables.tf

```
variable "filename" {

}
variable "content" {

}
variable "prefix" {

}
variable "separator" {

}
variable "length" {

}
```

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Variable Structure

main.tf

```
resource "local_file" "pet" {
    filename = var.filename
    content = var.content

}

resource "random_pet" "my-pet" {
    prefix = var.prefix
    separator = var.separator
    length = var.length
}
```

variables.tf

```
variable "filename" {

}
variable "content" {

}
variable "prefix" {

}
variable "separator" {

}
variable "length" {

}
```

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Interactive Mode

```
>_

$ terraform apply
var.content
  Enter a value: We love Pets!

var.filename
  Enter a value:  /root/pets.txt

var.length
  Enter a value:  2

var.prefix
  Enter a value:  Mrs.

var.separator
  Enter a value: .
```

WECAMP

Environment Variables

```
>_

$ export TF_VAR_filename="/root/pets.txt"
$ export TF_VAR_content="We love pets!"
$ export TF_VAR_prefix="Mrs"
$ export TF_VAR_separator="."
$ export TF_VAR_length="2"
$ terraform apply
```

WECAMP

Command Line Flags

```
$ terraform apply -var "filename=/root/pets.txt" -var "content=We love
Pets!"  -var "prefix=Mrs" -var "separator=." -var "length=2"
```

WECAMP

main.tf

```
resource "local_file" "pet" {
    filename = var.filename
    content = var.content

}

resource "random_pet" "my-pet" {
    prefix = var.prefix
    separator = var.separator
    length = var.length
}
```

variables.tf

```
variable "filename" {
        default = "/root/pets.txt"
}
variable "content" {
        default = "We love pets!"
}
variable "prefix" {
        default = "Mrs"
}
variable "separator" {
        default = "."
}
variable "length" {
        default = 2
}
```

WECAMP

main.tf

```
resource "local_file" "pet" {
    filename = var.filename
    content = var.content

}

resource "random_pet" "my-pet" {
    prefix = var.prefix
    separator = var.separator
    length = var.length
}
```

```
variable "filename" {
    default = "/root/pets.txt"
    type = string
    description = "the path of local file"
    sensitive = true
}
variable "content" {
    default = "I love pets!"
    type = string
    description = “the content of the file"

}
variable "prefix" {
    default = "Mrs"
    type = string
    description = "the prefix to be set"

}
variable "separator" {
    default = "."
```

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Variable Definition Files

terraform.tfvars

```
filename = "/root/pets.txt"
content = "We love pets!"
prefix = "Mrs"
separator = "."
length = "2"
```

```
>_

$ terraform apply -var-file variables.tfvars
```

Automatically Loaded

terraform.tfvars	terraform.tfvars.json
*.auto.tfvars	*.auto.tfvars.json

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7th Session (click here)

WECAMP

Terraform Variables – Output Values

Output values are like the return values of a Terraform module and have several uses

Terraform Variables Outputs

1

A root module can use outputs to print certain values in the CLI output after running terraform apply.

2

A child module can use outputs to expose a subset of its resource attributes to a parent module.

Advanced

When using remote state, root module outputs can be accessed by other configurations via a terraform_remote_state data source.

3

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Create Output Variables

```hcl
# Define output variables
output "virtual_machine_name" {
  description = "The name of the virtual machine"
  value       = vsphere_virtual_machine.saleh_vm.name
}

output "vm_state" {
  description = "The current state of the VM"
  value       = vsphere_virtual_machine.saleh_vm.power_state
}

output "vm_id" {
  description = "The ID of the VM"
  value       = vsphere_virtual_machine.saleh_vm.id
}
```

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Terraform Variables - Output Values

```
Plan: 1 to add, 0 to change, 0 to destroy.

Changes to Outputs:
  + virtual_machine_name = "saleh-vm"
  + vm_id                = (known after apply)
  + vm_state             = (known after apply)

Do you want to perform these actions?
  Terraform will perform the actions described above.
  Only 'yes' will be accepted to approve.

  Enter a value: yes

vsphere_virtual_machine.saleh_vm: Creating...
vsphere_virtual_machine.saleh_vm: Creation complete after 8s

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.

Outputs:

virtual_machine_name = "saleh-vm"
vm_id = "4233465a-f69d-332a-c3e1-7fd11c29f9c3"
vm_state = "on"
```

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File Resource and Outputs example

```
resource "local_file" "output_file" {
  filename = "./${var.vm_name}/output.txt"
  content  = <<EOF
The VM is powered ${vsphere_virtual_machine.saleh_vm.power_state}
EOF
}
```

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Terraform Output

main.tf

```
resource "local_file" "pet" {
  filename        = "pets.txt"
  content         = "We love pets!"
  file_permission = "0777"
}
resource "random_pet" "cat" {
  length    = "2"
  separator = "-"
}
output content {
  value       = local_file.pet.content
  sensitive   = false
  description = "Print the content of the file"

}
output pet-name {
  value       = random_pet.cat.id
  sensitive   = false
  description = "Print the name of the pet"

}
```

>_

```
$ terraform output
content = We love pets!
pet-name = huge-owl
```

```
$ terraform output pet-name
pet-name = huge-owl
```

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8th Session (click here)

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Terraform Variables – Local Values

A local value assigns a name to an expression, so you can use that name multiple times within a module without repeating it.

Local values are like a function's temporary local variables.

Once a local value is declared, you can reference it in expressions as local.<NAME>.

Local values can be helpful to avoid repeating the same values or expressions multiple times in a configuration

If overused they can also make a configuration hard to read by future maintainers by hiding the actual values used

The ability to easily change the value in a central place is the key advantage of local values.

In short, Use local values only in moderation

```
# Local Values Block
locals {
  vm_name = "${var.env}-${var.project_name}-vm"
}

# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {
  name     = local.vm_name
  num_cpus = var.vm_cpu
  memory   = var.vm_ram
```

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Don’t Repeat Yourself

DRY

Before DRY

```
x = 10;
print(10);
y = 10 + 20;
```

After DRY

```
value = 10;
print(value);
y = value + 20;
```

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DRY

9th Session (click here)

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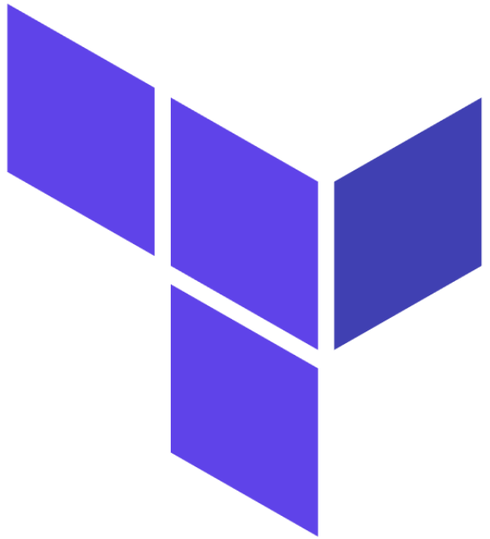
06 : Terraform Data Sources

- **Terraform Data Source**
- **Demo**



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Terraform Datasources

Data sources allow data to be fetched or computed for use elsewhere in Terraform configuration.

Use of data sources allows a Terraform configuration to make use of information defined outside of Terraform, or defined by another separate Terraform configuration.

A data source is accessed via a special kind of resource known as a *data resource*, declared using a data block

Each data resource is associated with a single data source, which determines the kind of object (or objects) it reads and what query constraint arguments are available

Data resources have the same dependency resolution behavior as defined for managed resources. Setting the depends_on meta-argument within data blocks defers reading of the data source until after all changes to the dependencies have been applied.

```
# Data Block
data "vsphere_datacenter" "dc" {
  name = "Datacenter-lab"
}

data "vsphere_compute_cluster" "cluster" {
  name          = "vSAN-lab"
  datacenter_id = data.vsphere_datacenter.dc.id
}

data "vsphere_datastore" "ds" {
  name          = "vsanDatastore"
  datacenter_id = data.vsphere_datacenter.dc.id
}

data "vsphere_network" "network" {
  name          = "VM Network"
  datacenter_id = data.vsphere_datacenter.dc.id
}
```

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Terraform Datasources

We can refer the data resource in a resource as depicted

```
# Resource Block
resource "vsphere_virtual_machine" "saleh_vm" {
  name      = var.vm_name
  num_cpus  = var.vm_cpu
  memory    = var.vm_ram

  resource_pool_id = data.vsphere_compute_cluster.
  datastore_id     = data.vsphere_datastore.ds.id
  guest_id = "otherGuest"

  network_interface {
    network_id   = data.vsphere_network.network.id
    adapter_type = "vmxnet3"
  }
```

Meta-Arguments for Datasources

Data resources support the provider meta-argument as defined for managed resources, with the same syntax and behavior.

Data resources do not currently have any customization settings available for their lifecycle, but the lifecycle nested block is reserved in case any are added in future versions.

Data resources support count and for_each meta-arguments as defined for managed resources, with the same syntax and behavior.
Each instance will separately read from its data source with its own variant of the constraint arguments, producing an indexed result.

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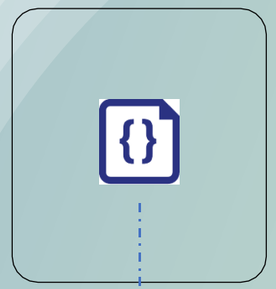

main.tf

```
resource "local_file" "pet" {
    filename = "/root/pets.txt"
    content = "We love pets!"
}
```

```
>_
$ cat /root/dog.txt
Dogs are awesome!
```

Real World Infrastructure

terraform.tfstate

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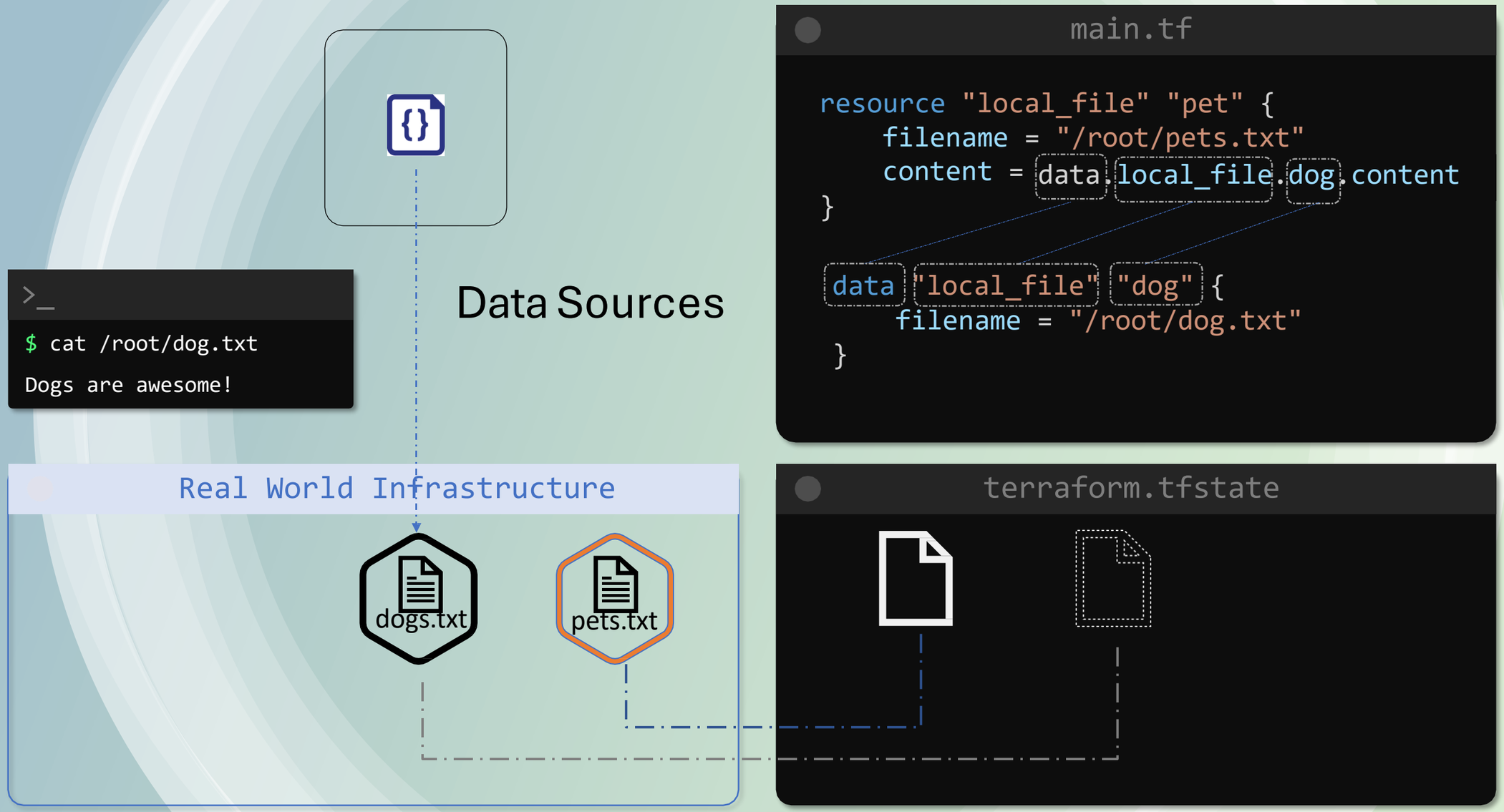
main.tf
resource "local_file" "pet" {
filename = "/root/pets.txt"
content = data.local_file.dog.content
}
data "local_file" "dog" {
filename = "/root/dog.txt"
}
Data Sources
>_
$ cat /root/dog.txt
Dogs are awesome!
Real World Infrastructure
dogs.txt
pets.txt
terraform.tfstate

10th Session (click here)

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07 : Terraform Provisioner

- Terraform Provisioners
- Types of Provisioners
- Connection Block
- File Provisioner
- local-exec Provisioner
- remote-exec Provisioner
- Null-Resource & Provisioners
- Demo

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Terraform Provisioners

Provisioners can be used to model specific actions on the local machine or on a remote machine in order to prepare servers

Passing data into virtual machines and other compute resources

Running configuration management software (packer, chef, ansible)

Creation-Time Provisioners

Failure Behaviour: Continue: Ignore the error and continue with creation or destruction.

Provisioners are a Last Resort

First-class Terraform provider functionality may be available

Destroy-Time Provisioners

Failure Behaviour: Fail: Raise an error and stop applying (the default behavior). If creation provisioner, taint resource

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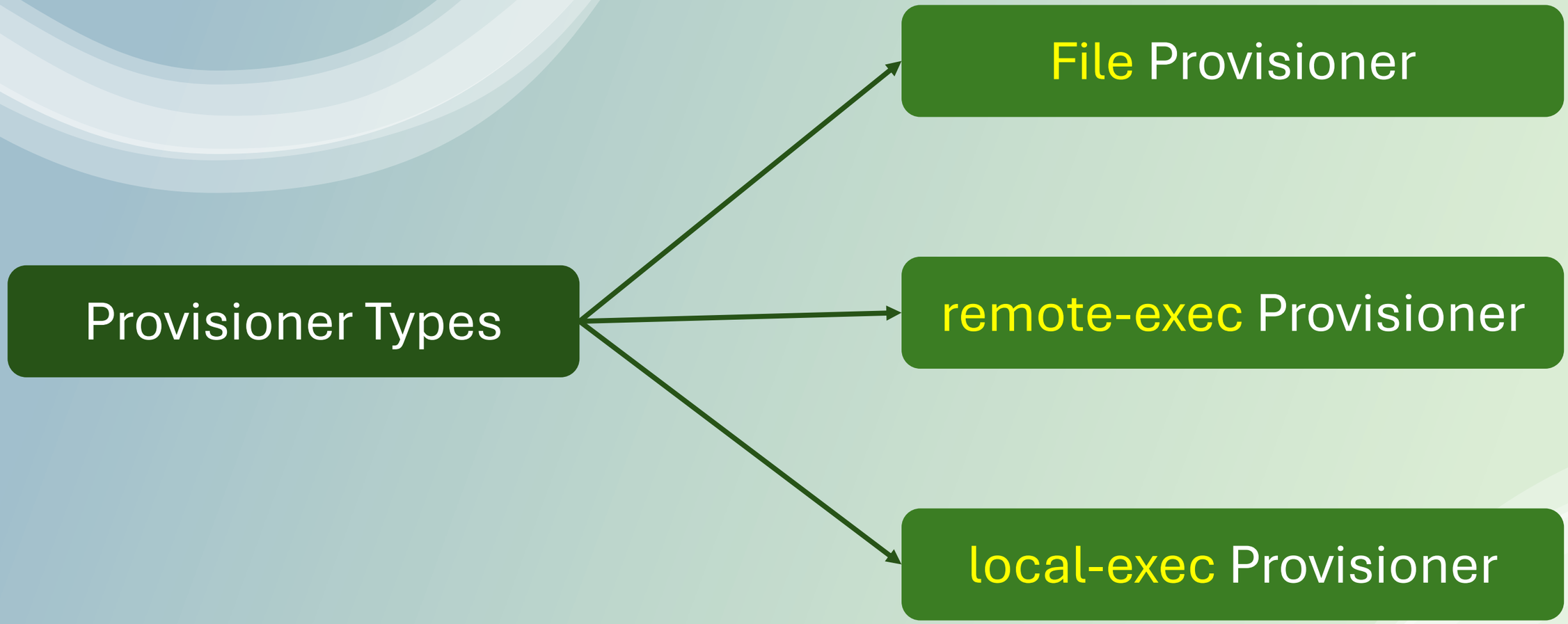
Types of Provisioners



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Connection Block

Most provisioners require access to the remote resource via SSH or WinRM, and expect a nested connection block with details about how to connect.

Expressions in connection blocks cannot refer to their parent resource by name. Instead, they can use the special self object.

```
connection {
  type        = "ssh"
  user        = var.ssh_user
  password    = var.ssh_pass
  host        = self.default_ip_address
}
```

```
connection {
  type      = "winrm"
  user      = "administrator"
  password  = "Adm!n!stR@t0r"
  host      = self.default_ip_address
  https     = false
  port      = 5985
  insecure  = true
}
```

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File Provisioner

File Provisioner

- File Provisioner is used to copy files or directories from the machine executing Terraform to the newly created resource.
- The file provisioner supports both ssh and winrm type of connections

```
provisioner "file" {
  source      = "scripts/hello.sh"
  destination = "/tmp/hello.sh"

  connection {
    type        = "ssh"
    user        = var.ssh_user
    password    = var.ssh_pass
    host        = self.default_ip_address
  }
}
```

```
provisioner "file" {
  source      = "scripts/hello.sh"
  destination = "/tmp/hello.sh"
}

connection {
  type        = "ssh"
  user        = var.ssh_user
  password    = var.ssh_pass
  host        = self.default_ip_address
}
```

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remote-exec Provisioner

remote-exec Provisioner

- The remote-exec provisioner invokes a script on a remote resource after it is created.
- This can be used to run a configuration management tool, bootstrap into a cluster, etc.

```
provisioner "remote-exec" {
  inline = [
    "chmod +x /tmp/hello.sh",
    "bash /tmp/hello.sh"
  ]

  connection {
    type        = "ssh"
    user        = var.ssh_user
    password    = var.ssh_pass
    host        = self.default_ip_address
  }
}
```

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local-exec Provisioner

local-exec Provisioner

- The local-exec provisioner invokes a local executable after a resource is created.
- This invokes a process on the machine running Terraform, not on the resource.

```
provisioner "local-exec" {
  command = "echo 'VM ${self.name} created on Today!' >> ./logs/vm_creation.log && false"
}
```

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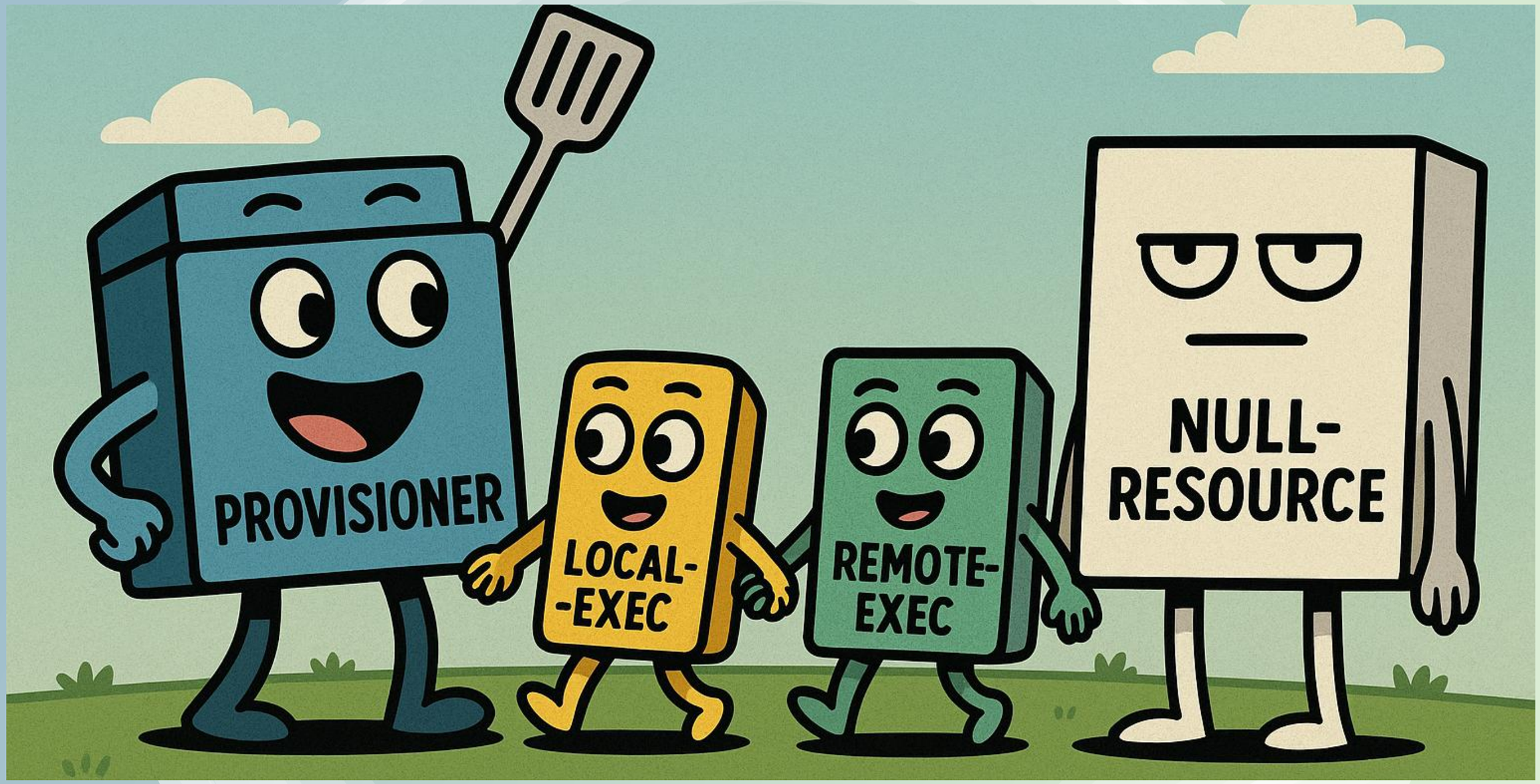

NULL Provider & NULL Resource

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Null-Resource & Provisioners

null provider
null_resource

- If you need to run provisioners that aren't directly associated with a specific resource, you can associate them with a null_resource.
- Instances of null_resource are treated like normal resources, but they don't do anything.
- Same as other resource, you can configure provisioners and connection details on a null_resource.

```
required_providers {
  vsphere = {
    source  = "hashicorp/vsphere"
    version = "2.8.1"
  }
  local = {
    source  = "hashicorp/local"
    version = "2.5.1"
  }
  null = {
    source  = "hashicorp/null"
    version = "3.2.2"
  }
```

```
resource "null_resource" "log_vm_creation" {
  provisioner "local-exec" {
    command     = "echo 'VM ${var.vm_name} created on Today!' >> ./logs/vm_creation.log"
    interpreter = ["/bin/bash", "-c"]
  }

  depends_on = [
    vsphere_virtual_machine.this
  ]
}
```

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11th Session (click here)

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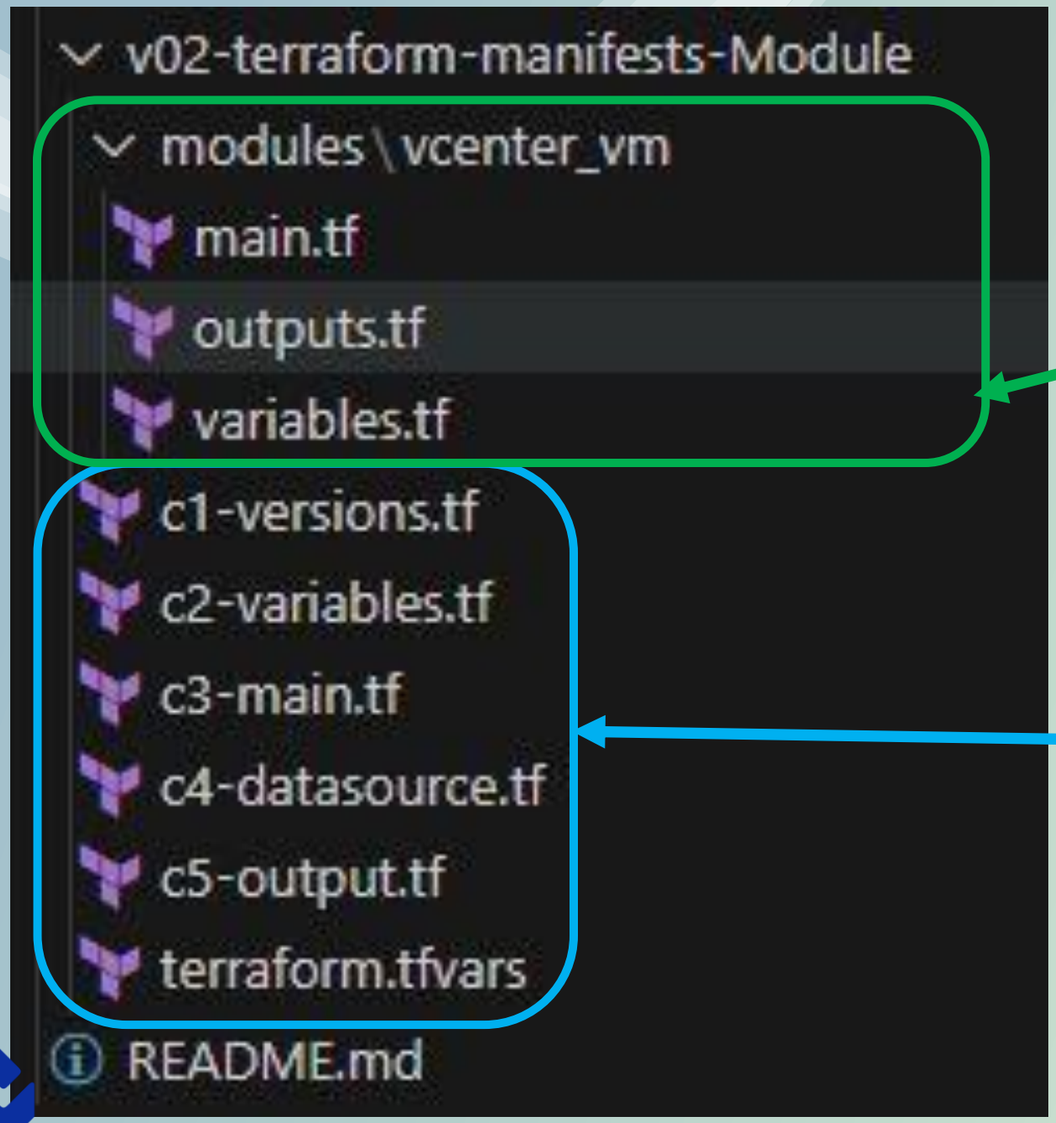
Root Module and Child Module



Child Module

Root Module

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Root Module vs Child Module

Child Module	Root Module	Characteristic
No ❌	Yes (with `terraform apply`) ✅	Direct execution
Yes – must be called by another module ✅	No ❌	Requires invocation from elsewhere
No – only through a parent module ❌	Yes ✅	Executed independently
No – usually does not include provider ❌	Yes ✅	Typically includes provider

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Terraform Modules

Modules are containers for multiple resources that are used together. A module consists of a collection of .tf files kept together in a directory.

Modules are the main way to package and reuse resource configurations with Terraform.

A module that has been called by another module is often referred to as a child module.

Every Terraform configuration has at least one module, known as its root module, which consists of the resources defined in the .tf files in the main working directory

Child modules can be called multiple times within the same configuration, and multiple configurations can use the same child module.

A Terraform module (usually the root module of a configuration) can call other modules to include their resources into the configuration.

In addition to modules from the local filesystem, Terraform can load modules from a public or private registry.

This makes it possible to publish modules for others to use, and to use modules that others have published.

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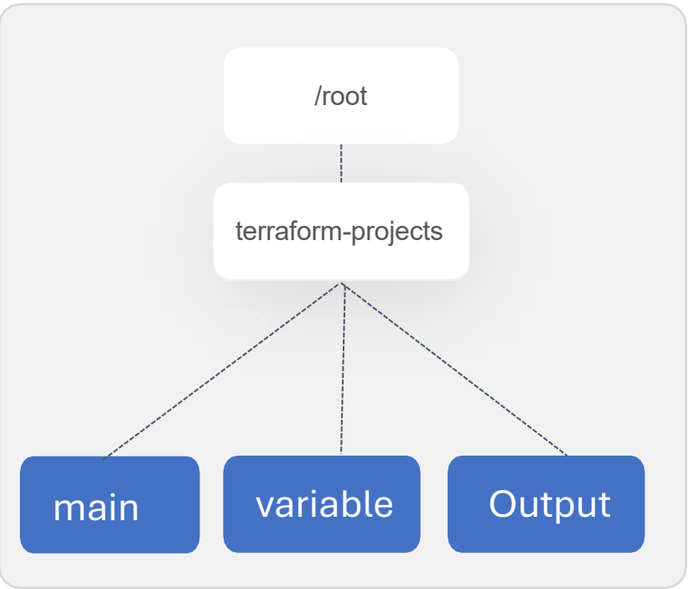
```
>_
$ ls /root/terraform-projects/v01-terraform-playground-Simple
main.tf   variables.tf    output.tf
```

main.tf

```hcl
resource "local_file" "pet" {
  filename = var.filename
  content  = var.content
}

resource "random_pet" "my-pet" {
  prefix    = var.prefix
  separator = var.separator
  length    = var.length
}
```



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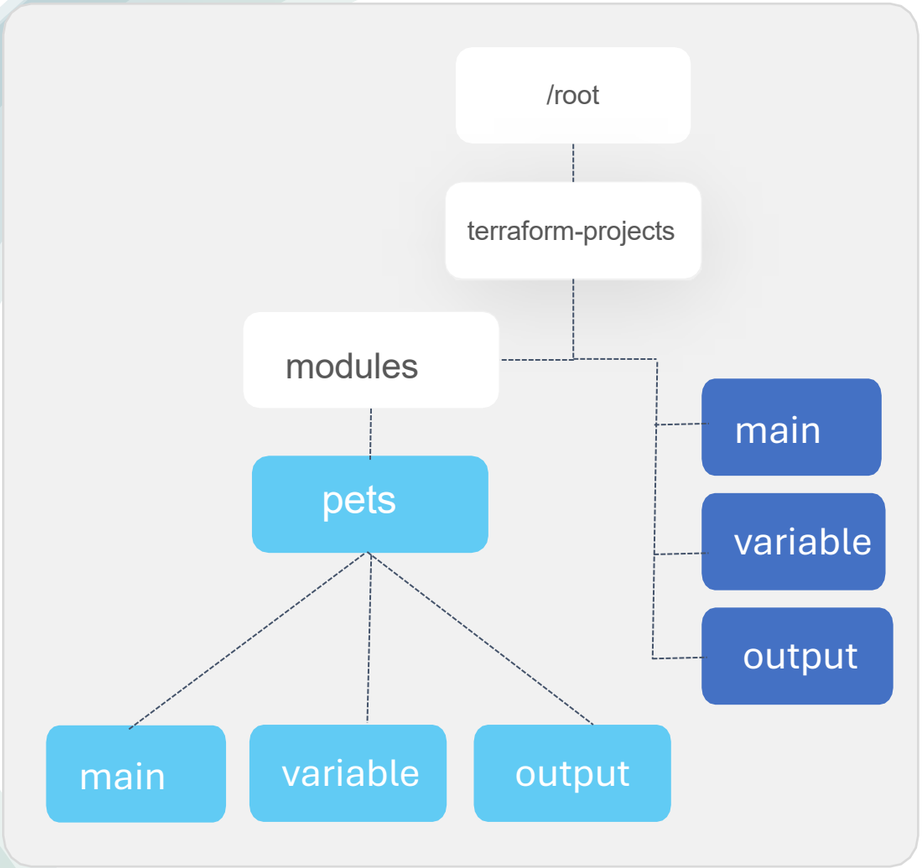
modules/pets/main.tf

```
resource "local_file" "pet" {
  filename = var.filename
  content  = var.content
}

resource "random_pet" "my-pet" {
  prefix    = var.prefix
  separator = var.separator
  length    = var.length
}
```

main.tf

```
module "pets_module" {
  source    = "./modules/pets"
  filename  = var.filename
  content   = var.content
  prefix    = var.prefix
  separator = var.separator
  length    = var.length
}
```



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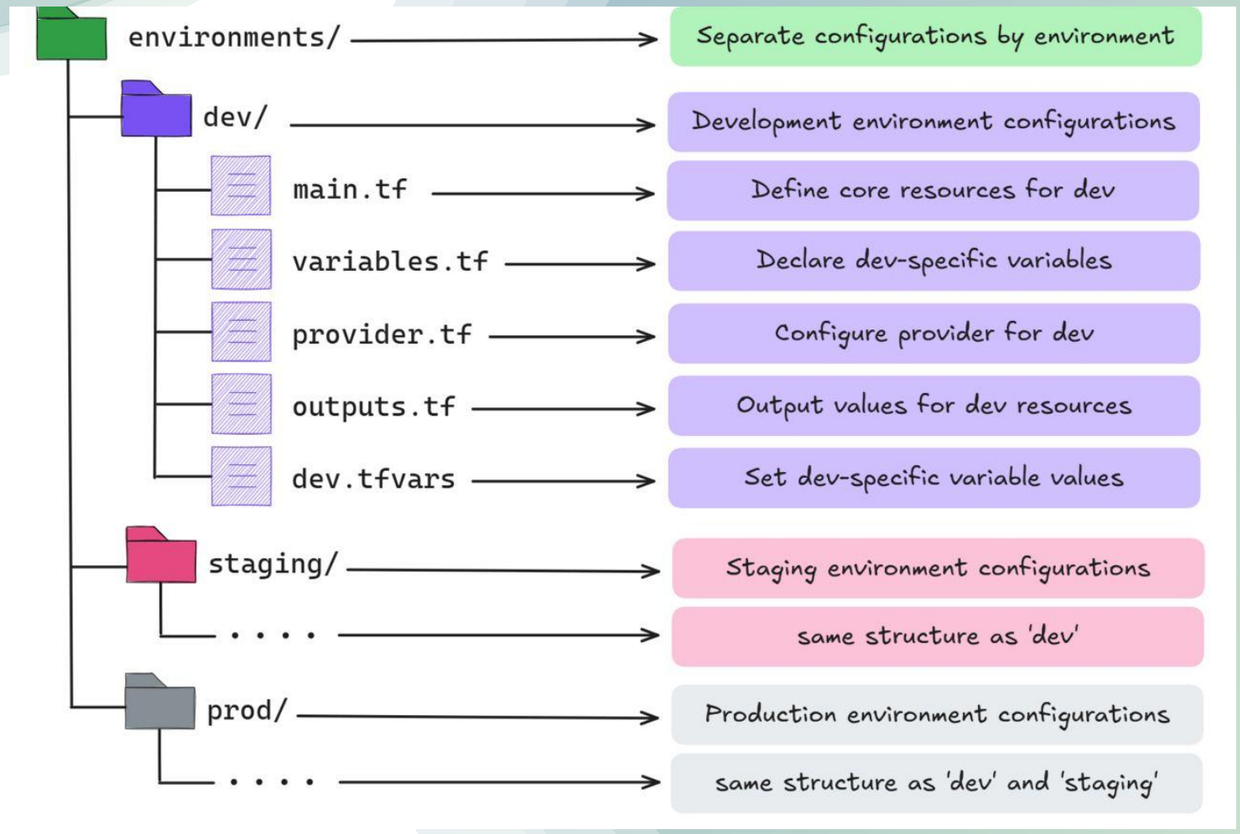
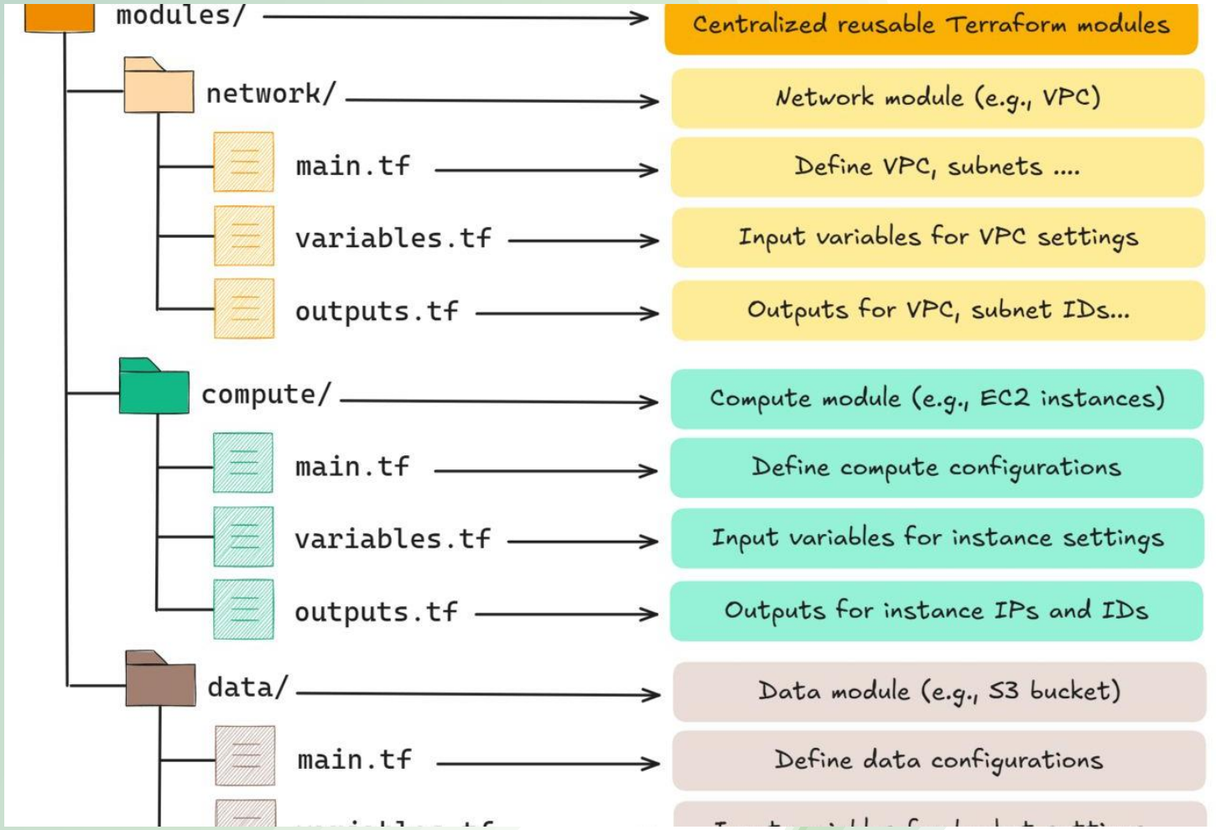
Terraform Module Structure





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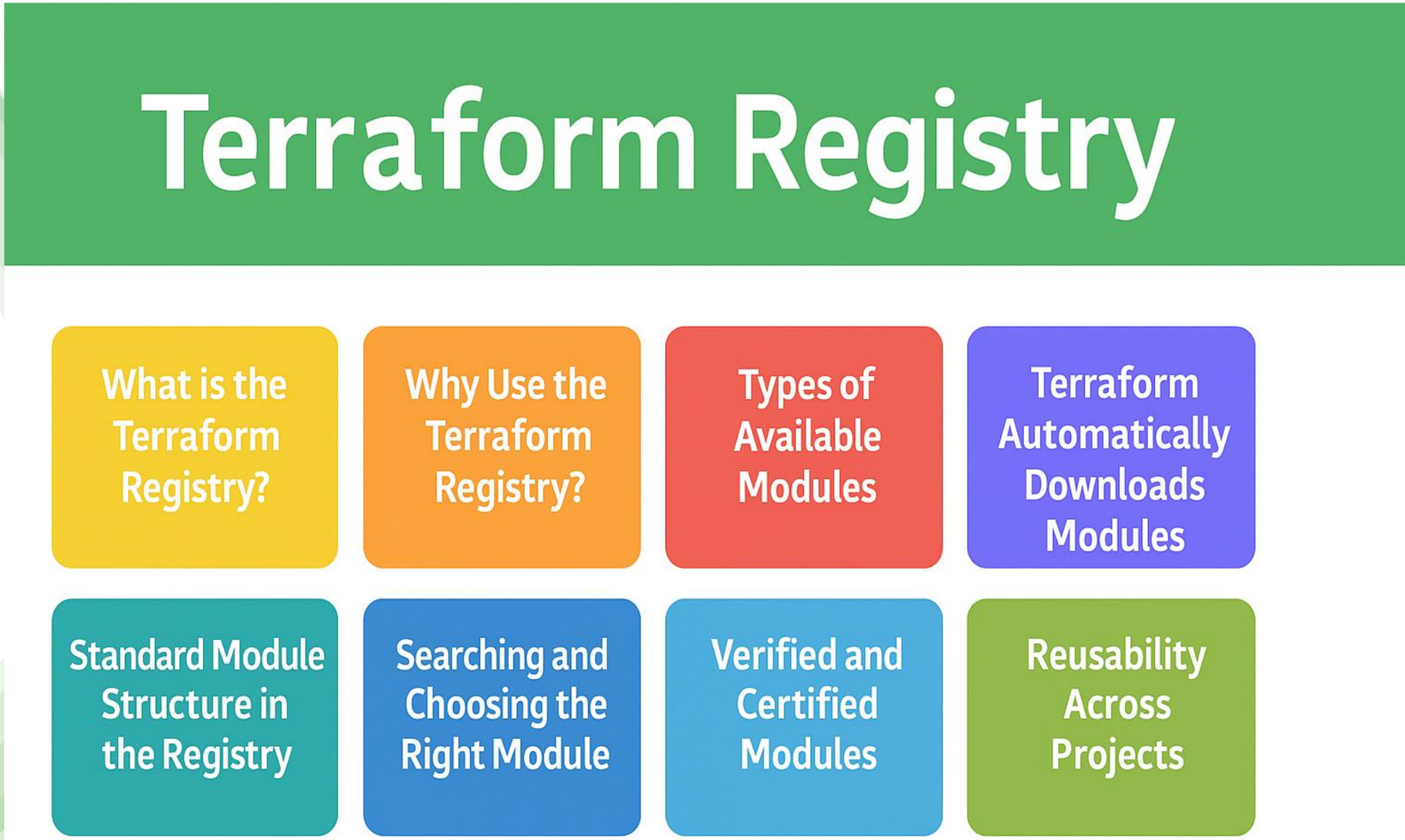
Terraform Registry: Publicly Available Modules



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```
# Module Block

module "saleh_vm" {
  source            = "modules/vcenter_vm"
  vm_name           = var.vm_name
  num_cpus          = var.num_cpus
  memory            = var.memory
  resource_pool_id  = data.vsphere_compute_cluster.cluster.resource_pool_id
  datastore_id      = data.vsphere_datastore.ds.id
  guest_id          = "otherGuest"
  network_id        = data.vsphere_network.network.id
  adapter_type      = "vmxnet3"
  vm_size           = var.vm_size
  eagerly_scrub     = var.eagerly_scrub
  thin_provisioned  = var.thin_provisioned
}
```

12th Session (click here)

WECAMP

09 : Terraform Commands

- Terraform Validate
- Terraform Format
- Terraform Show
- Terraform Providers
- Terraform Output
- Terraform Refresh
- Terraform Graph
- Demo

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Terraform validate

main.tf

```
resource "local_file" "pet" {
    filename = "/root/pets.txt"
    content = "We love pets!"
    file_permissions = "0700"
}
```

>_

```
$ terraform validate
Success! The configuration is valid.

$ terraform validate

Error: Unsupported argument

  on main.tf line 4, in resource "local_file" "pet":
   4:     file_permissions = "0777"

An argument named "file_permissions" is not expected
here. Did you mean "file_permission"?
```

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Terraform format

main.tf

```
resource "local_file" "pet" {
    filename        = "/root/pets.txt"
    content         = "We love pets!"
    file_permission = "0700"
}
```

>_

```
$ terraform fmt
main.tf
```

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Terraform show

```
$ terraform show
# local_file.pet:
resource "local_file" "pet" {
    content              = "We love pets!"
    directory_permission = "0777"
    file_permission      = "0777"
    filename             = "/root/pets.txt"
    id                   =
"cba595b7d9f94ba1107a46f3f731912d95fb3d2c"
}
```

```
$ terraform show -json
{"format_version":"0.1","terraform_version":"0.13.0
","values":{"root_module":{"resources":[{"address":
"local_file.pet","mode":"managed","type":"local_fil
e","name":"pet","provider_name":"registry.terraform
.io/hashicorp/local","schema_version":0,"values":{"
content":"We love
pets!","content_base64":null,"directory_permission"
:"0777","file_permission":"0777","filename":"/root/
pets.txt","id":"cba595b7d9f94ba1107a46f3f731912d95f
b3d2c","sensitive_content":null}}]}}}
```

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Terraform providers

main.tf

```
resource "local_file" "pet" {
    filename        = "/root/pets.txt"
    content         = "We love pets!"
    file_permission = "0700"
}
```

>_

```
$ terraform providers
Providers required by configuration:
.
└── provider[registry.terraform.io/hashicorp/local]

Providers required by state:

    provider[registry.terraform.io/hashicorp/local]



$ terraform providers mirror /root/terraform/new_local_file
- Mirroring hashicorp/local...
  - Selected v1.4.0 with no constraints
  - Downloading package for windows_amd64...
  - Package authenticated: signed by HashiCorp
```

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Terraform output

main.tf

```
resource "local_file" "pet" {
  filename        = "/root/pets.txt"
  content         = "We love pets!"
  file_permission = "0777"
}
resource "random_pet" "cat" {
  length    = "2"
  separator = "-"
}
output content {
  value       = local_file.pet.content
  sensitive   = false
  description = "Print the content of the file"

}
output pet-name {
  value       = random_pet.cat.id
  sensitive   = false
  description = "Print the name of the pet"

}
```

>_

```
$ terraform output
content = We love pets!
pet-name = huge-owl



$ terraform output pet-name
pet-name = huge-owl
```

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Terraform refresh

main.tf

```
resource "local_file" "pet" {
  filename        = "/root/pets.txt"
  content         = "We love pets!"
  file_permission = "0777"
}
resource "random_pet" "cat" {
  length    = "2"
  separator = "-"
}
```

>_

```
$ terraform refresh
random_pet.cat: Refreshing state... [id=huge-owl]
local_file.pet: Refreshing state...
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]



$ terraform plan
Refreshing Terraform state in-memory prior to plan...
The refreshed state will be used to calculate this
plan, but will not be
persisted to local or remote state storage.

random_pet.cat: Refreshing state... [id=huge-owl]
local_file.pet: Refreshing state...
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]
------------------------------------------------------------

No changes. Infrastructure is up-to-date.
```

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Terraform Graph

main.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content  = "My favorite pet is ${random_pet.my-pet.id}"
}
resource "random_pet" "my-pet" {
  prefix = "Mr"
  separator = "."
  length = "1"
}
```

>_

```
$ terraform graph
digraph {
        compound = "true"
        newrank = "true"
        subgraph "root" {
                "[root] local_file.pet (expand)" [label = "local_file.pet", shape = "box"]
                "[root] provider[\"registry.terraform.io/hashicorp/local\"]" [label = "provider[\"registry.terraform.io/hashicorp/local\"]", shape = "diamond"]
                "[root] provider[\"registry.terraform.io/hashicorp/random\"]" [label = "provider[\"registry.terraform.io/hashicorp/random\"]", shape = "diamond"]
                "[root] random_pet.my-pet (expand)" [label = "random_pet.my-pet", shape = "box"]
                "[root] local_file.pet (expand)" -> "[root] provider[\"registry.terraform.io/hashicorp/local\"]"
                "[root] local_file.pet (expand)" -> "[root] random_pet.my-pet (expand)"
                "[root] meta.count-boundary (EachMode fixup)" -> "[root] local_file.pet (expand)"
                "[root] provider[\"registry.terraform.io/hashicorp/local\"] (close)" ->
```

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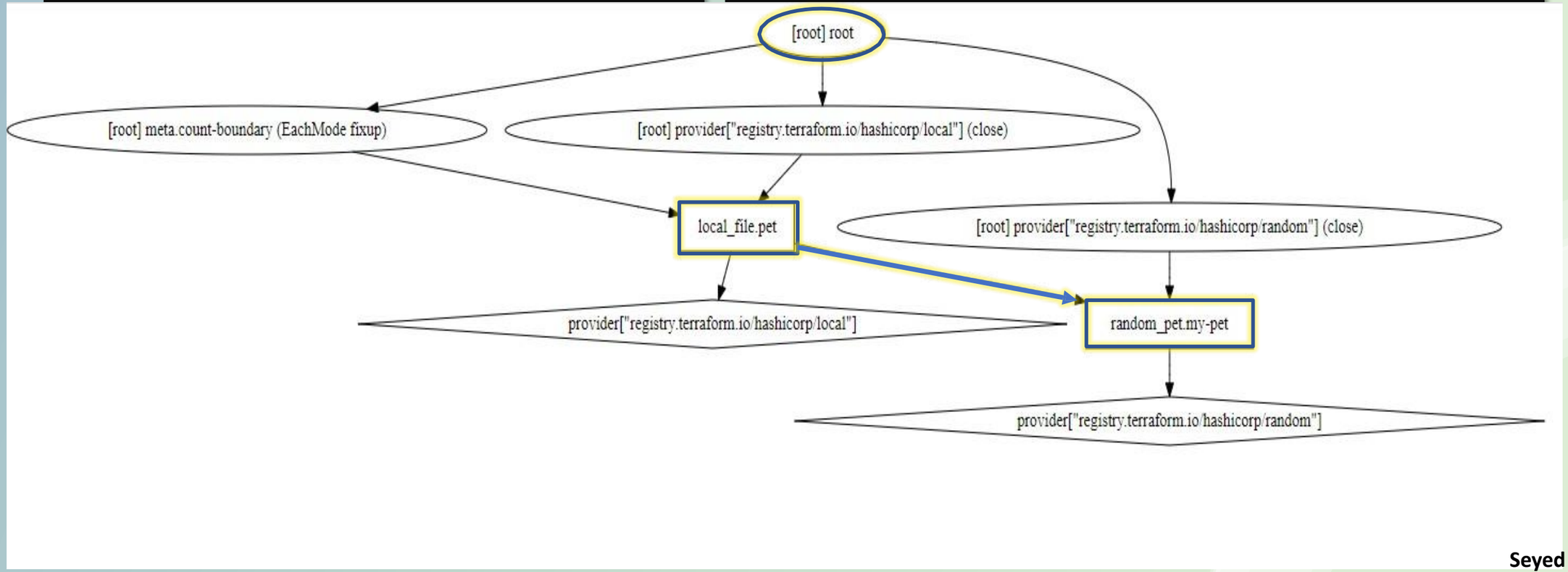
main.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content  = "My favorite pet is ${random_pet.my-pet.id}"
}
resource "random_pet" "my-pet" {
  prefix = "Mr"
  separator = "."
  length = "1"
}
```

>_

```
$ apt update
$ apt install graphviz -y
$ terraform graph | dot -Tsvg > graph.svg
```



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13th Session (click here)

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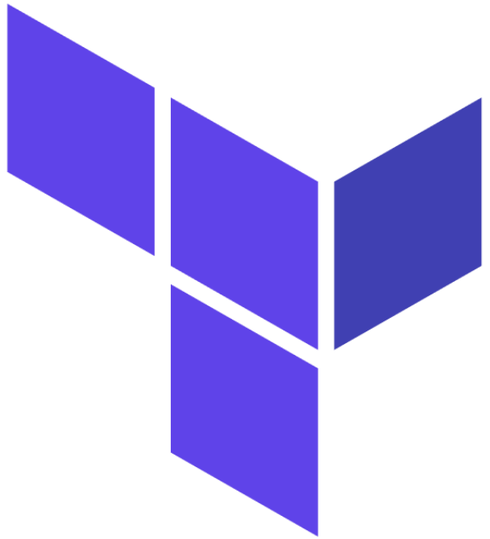
10 : Terraform Debug

- **Log Levels**
- **Demo**



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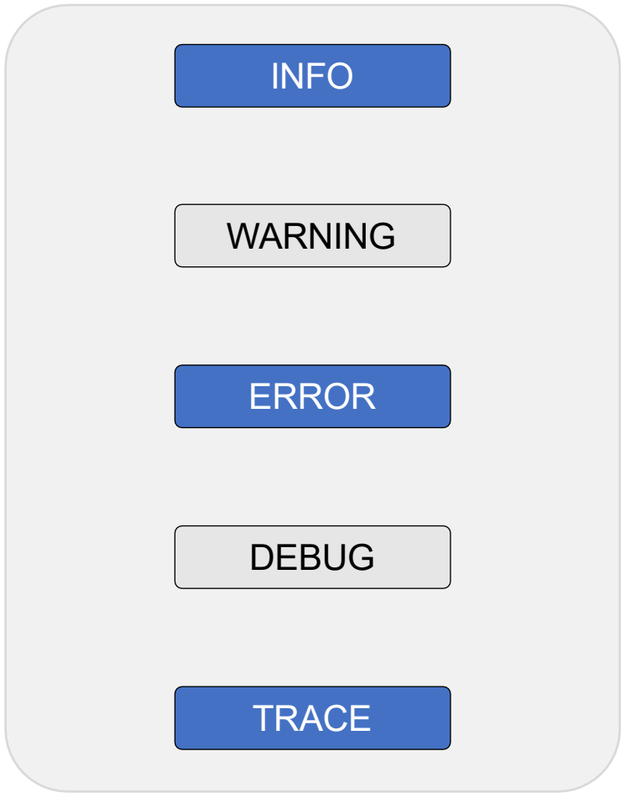
Log Levels

```
>_
# export TF_LOG=<log_level>
$ export TF_LOG=TRACE
```



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```
>_

  $ terraform plan
 ----
2020/10/18 22:08:30 [INFO] Terraform version: 0.13.0
2020/10/18 22:08:30 [INFO] Go runtime version: go1.14.2
2020/10/18 22:08:30 [INFO] CLI args: []string{"C:\\Windows\\system32\\terraform.exe", "plan"}
2020/10/18 22:08:30 [DEBUG] Attempting to open CLI config file: C:\Users\vpala\AppData\Roaming\terraform.rc
2020/10/18 22:08:30 [DEBUG] File doesn't exist, but doesn't need to. Ignoring.
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory terraform.d/plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory C:\Users\vpala\AppData\Roaming\terraform.d\plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
C:\Users\vpala\AppData\Roaming\HashiCorp\Terraform\plugins
2020/10/18 22:08:30 [INFO] CLI command args: []string{"plan"}
2020/10/18 22:08:30 [WARN] Log levels other than TRACE are currently unreliable, and are supported only for backward
compatibility.
  Use TF_LOG=TRACE to see Terraform's internal logs.
  ----
2020/10/18 22:08:30 [DEBUG] New state was assigned lineage "f413959c-538a-f9ce-524e-1615073518d4"
2020/10/18 22:08:30 [DEBUG] checking for provisioner in "."
2020/10/18 22:08:30 [DEBUG] checking for provisioner in "C:\\Windows\\system32"
2020/10/18 22:08:30 [INFO] Failed to read plugin lock file .terraform\plugins\windows_amd64\lock.json: open
.terraform\plugins\windows_amd64\lock.json: The system cannot find the path specified.
2020/10/18 22:08:30 [INFO] backend/local: starting Plan operation
2020-10-18T22:08:30.625-0400 [INFO]  plugin: configuring client automatic mTLS
2020-10-18T22:08:30.646-0400 [DEBUG] plugin: starting plugin:
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe
args=[.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe]
2020-10-18T22:08:30.935-0400 [DEBUG] plugin: plugin started:
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe
pid=34016
2020-10-18T22:08:30.935-0400 [DEBUG] plugin: waiting for RPC address:
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe
2020-10-18T22:08:30.974-0400 [INFO]  plugin.terraform-provider-aws_v3.11.0_x5.exe: configuring server automatic mTLS:
```

```
$ export TF_LOG_PATH=/tmp/terraform.log


$ head -10 /tmp/terraform.logs
----
2020/10/18 22:08:30 [INFO] Terraform version: 0.13.0
2020/10/18 22:08:30 [INFO] Go runtime version: go1.14.2
2020/10/18 22:08:30 [INFO] CLI args: []string{"C:\\Windows\\system32\\terraform.exe",
"plan"}
2020/10/18 22:08:30 [DEBUG] Attempting to open CLI config file:
C:\Users\vpala\AppData\Roaming\terraform.rc
2020/10/18 22:08:30 [DEBUG] File doesn't exist, but doesn't need to. Ignoring.
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
terraform.d/plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
C:\Users\vpala\AppData\Roaming\terraform.d\plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
C:\Users\vpala\AppData\Roaming\HashiCorp\Terraform\plugins
2020/10/18 22:08:30 [INFO] CLI command args: []string{"plan"}


$ unset TF_LOG_PATH
```

14th Session (click here)

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